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A CROSS-SECTIONAL STUDY ON CORRELATION OF VENOUS REFLUX GRADING IN VARICOSE VEINS PATIENTS BY VENOUS DOPPLER AND ITS CORRELATION WITH VENOUS CLINICAL SEVERITY SCORE (VCSS) AND VENOUS DISABILITY SCORE (VDS)

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ABSTRACT

Varicose veins are a common manifestation of chronic venous disease and are frequently associated with venous reflux, resulting in significant clinical symptoms and functional impairment. Doppler ultrasonography plays a vital role in evaluating venous reflux and disease severity. To correlate venous reflux grading assessed by Doppler ultrasonography with the Venous Clinical Severity Score (VCSS) and Venous Disability Score (VDS) in patients with varicose veins. This hospital-based analytical cross-sectional study included 60 patients with varicose veins who underwent clinical evaluation and venous Doppler ultrasonography. Venous reflux was graded based on reflux duration and correlated with VCSS and VDS. Statistical analysis was done using Chi-square test, one-way ANOVA, and Spearman correlation analysis. Grade II reflux was the most common reflux category. Significant positive correlations were observed among reflux grade and VCSS ($r = 0.914$, $p < 0.001$) and among reflux grade and VDS ($r = 0.835$, $p < 0.001$). Patients with severe reflux demonstrated significantly higher clinical severity and disability scores compared to those with lower reflux grades. Venous reflux grading by Doppler ultrasonography showed a strong positive correlation with both VCSS and VDS. Doppler-derived reflux assessment is a reliable objective tool for evaluating disease severity and functional disability in individual with varicose veins.

KEYWORDS: Varicose veins, Venous reflux, Doppler ultrasonography, Venous Clinical Severity Score, Venous Disability Score.

1. INTRODUCTION

Varicose veins are distended, elongated, and tortuous veins that occur commonly as one of the manifestations of chronic venous disease and play a significant role in causing a burden on global healthcare (Kikuchi et al., 2023). Their incidence rises with increased age and is affected by variables such as age, gender, and body mass index (Shrestha & Karmacharya, 2020). Occupation-related factors including standing have been shown to be another important cause of the disease (Shakya et al., 2020). Varicose veins impact not only aesthetics but also impair physical function, quality of life, and work productivity (Patel et al., 2024). Varicose vein pathophysiology is mostly linked with incompetent venous valves that cause venous reflux and hypertension (Azar et al., 2022). High pressure within the veins leads to venous dilatation and conditions such as edema, skin alterations, and ulcers (Carman & Al-Omari, 2019). Advanced venous conditions have been reported to be associated with severe hemodynamic problems and poor clinical results (Shaalan et al., 2021). Thrombotic and post-thrombotic processes can also impact the severity of venous disease (Aksoy et al., 2021).

Doppler venous ultrasonography is considered to be the gold standard diagnostic modality for lower limb venous pathologies due to its ability to give a precise assessment of the venous anatomy and physiology (Adler et al., 2022). Contemporary Doppler methodologies allow obtaining objective results regarding the parameters of blood flow and its velocity (Bechsgaard et al., 2018). The use of Doppler ultrasound allows examining such anatomical structures as the saphenofemoral and saphenopopliteal junctions, perforators, and deep veins to diagnose venous diseases accurately (Choi et al., 2022). Moreover, recent research found an association between venous insufficiency and great saphenous vein diameter in varicose veins patients (Sai Harathi et al., 2025). Clinical assessment is still crucial in evaluating disease

severity and treatment effectiveness. The Venous Clinical Severity Score (VCSS) is a valid measure that helps evaluate the burden of disease and the progression of the illness (Gohel, 2024). Another measure called the Venous Disability Score (VDS) assists in assessing the impact of venous disease on one's ability to perform their everyday functions (Mallick et al., 2020). In previous research, positive associations between VCSS and ultrasound-detected reflux measurements were found (Darwisa et al., 2020); additionally, connections between this score and quality-of-life measures have been noted (Poulose et al., 2021).

While much progress has been made in Doppler ultrasound imaging and clinical score measurements, understanding the connection between reflux severity and clinical symptoms is still not clear. Research into the association between venous diameter and reflux has found correlations between anatomical findings and the severity of disease (Panpikoon et al., 2022). A prospective study investigating the duration of reflux found an interesting correlation with Venous Clinical Severity Score, indicating that Doppler ultrasound findings can be used objectively to estimate the severity of the disease (Kokkinidis et al., 2023).

This research was designed to compare the grading of venous reflux in the legs of individuals with varicose veins utilizing venous Doppler ultrasound scanning methods. The first purpose of this research was to correlate venous reflux grading with VCSS, while the second goal was to correlate venous reflux grading with VDS.

Objectives of the study

Primary Objective

To correlate the grading of varicose veins using venous Doppler ultrasonography with the VCSS.

Secondary Objective

To correlate the grading of varicose veins using venous Doppler ultrasonography with the VDS.

2. METHODOLOGY

2.1 Study Design and Duration

The present investigation is a hospital-based analytical cross-sectional study in order to ascertain the relationship between different levels of severity of venous reflux as determined using Doppler ultrasound with clinical presentation among patients suffering from varicose veins. This study was done at the Radiology Department of a tertiary care healthcare institute located in the Chengalpattu district, which regularly gets referred cases for venous Doppler examination in patients suffering from lower limb vein disease. The period of this study was eighteen months starting from April 2024 to October 2025.

2.2 Study Population

Participants selected for this research were those adult patients of either sex who have been sent for investigation for the presence of varicose veins using venous Doppler. This was done using eligibility criteria formulated at the onset of the experiment, following the signing of informed consent forms.

2.3 Inclusion and Exclusion Criteria

Participants in this investigation consisted of patients identified with varicose veins and subsequently referred to the Department of Radiology for doppler ultrasonography of the veins. Eligibility criteria included with clinically suspected varicose veins in the age range of 18 to 70 years of both genders with informed consent following an explanation of the goals and procedure of the study. Exclusion criteria included patients having a previous history of intra-abdominal or pelvic malignancies, deep vein thrombosis, peripheral arterial disease associated with varicose veins, and pregnant females.

2.4 Sample Size

A total of 60 patients with varicose veins who fulfilled the eligibility criteria were included in the study. All these selected patients underwent comprehensive clinical evaluation and venous doppler ultrasonography. Information obtained from these processes was used to assess the relationship between venous reflux grade and VCSS and VDS scores.

2.5 Clinical Assessment and Severity Scoring

All subjects participating in the study underwent clinical evaluation. A standardized form was used for data collection on presenting complaints, duration of complaints, and history of ulceration. Physical exam included assessment of the presence of varicosities, edema, pigmented skin, inflammation, and induration. The clinical severity was determined based on the VCSS, a scoring index that is used to evaluate ten parameters, such as pain, varicose veins, venous oedema, pigmented skin, inflammation, induration, the quantity, size, and duration of ulcers, as well as the application of compression therapy. Functional disability was determined based on the VDS scale, which is a grading scale from 0 to 3 reflecting disability associated with venous diseases.

2.6 Doppler Ultrasonography Protocol

Venous doppler ultrasonography was performed using the Mindray DC-60 and Mindray DC-80 ultrasound machines. Transducer choice was determined by the body habitus of patients and the depths of veins under examination. Linear probe of frequency 7–12 MHz was employed in the assessment of superficial veins, such as both the short and long saphenous veins. For the patient with bigger body habitus, a curvilinear probe with a frequency of 2.5 to 3.5 Mhz was employed to allow the assessment of deep veins.

2.7 Doppler Parameters Assessed and Grading of Venous Reflux

Doppler ultrasound scanning was done in order to assess the nature and the level of involvement of the venous system. There are different classifications of the venous system; either the saphenous veins, both long and short, or both are involved. The competency of the saphenofemoral and saphenopopliteal junctions was evaluated, along with the competency of the perforator veins. Deep venous system patency and any sign of thrombosis was also assessed. The level of reflux was expressed in seconds and used for classification of venous reflux.

- Superficial veins: reflux >0.5 s
- Deep veins: reflux >1.0 s

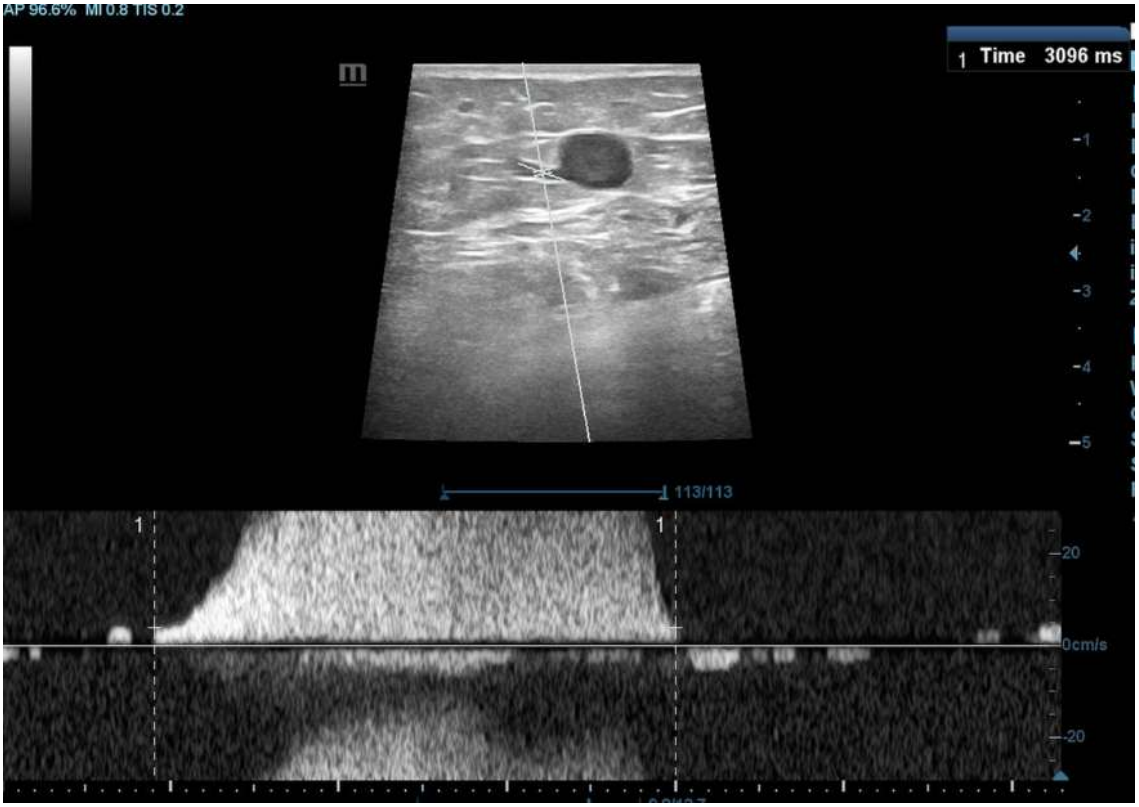

Fig : 1 Spectral venous Doppler image of great saphenous vein with perforator at the level of mid thigh demonstrating prolonged retrograde venous flow (venous reflux) with a reflux duration of 3096 ms (3.096 s) which is suggestive of incompetent perforator of great saphenous vein.

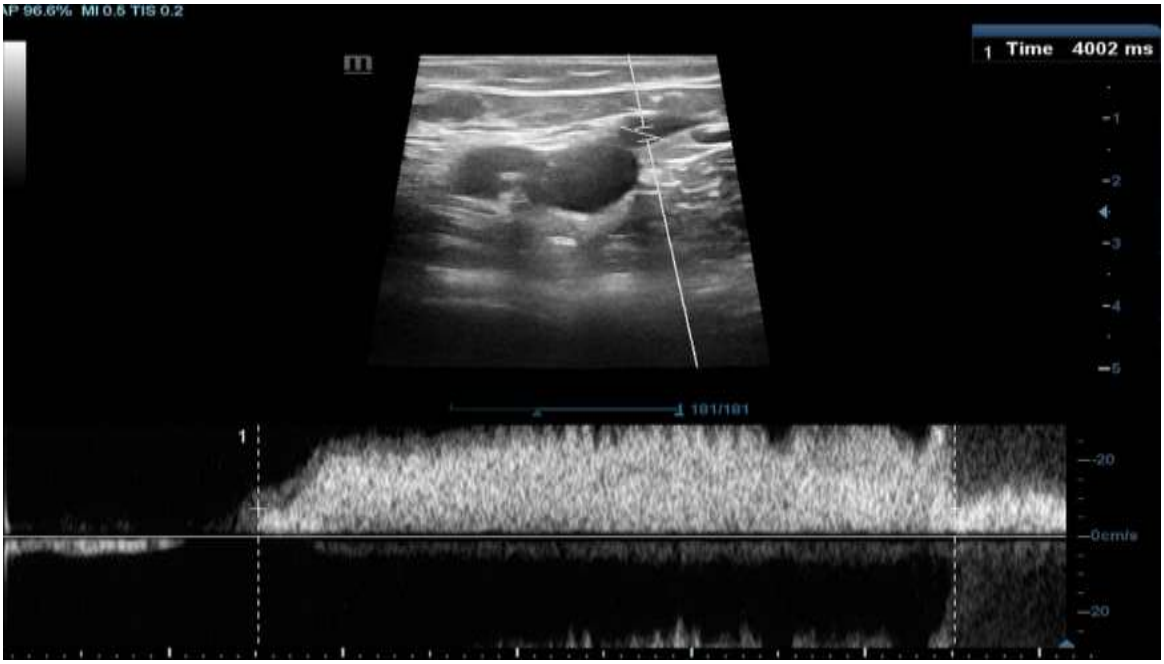

Fig : 2. Spectral venous Doppler image at the level of sapheno-femoral junction demonstrating prolonged retrograde venous flow (venous reflux) with a reflux duration of 4002ms (4.002 s) which is suggestive of incompetent sapheno-femoral junction.

2.8 Statistical Analysis

The collected information were entered on Microsoft Excel and was statistically analyzed using SPSS version 17. The descriptive statistic was used to analyze the demographics, clinical features, and Doppler properties of the subjects. For the relationship among categorical variables, the chi-square test was done while for the differences in means among the reflux grades in relation to VCSS and VDS, a one-way ANOVA was performed. Relationships between reflux grades and clinical scoring system were verified using Spearman correlation analysis. A significant p-value was defined as less than 0.05.

2.9 Ethical Considerations

All ethical considerations were adhered to during the course of the investigation. Written consent was provided by each and every participant before including them into the experiment, after explaining to them the goals and methods of the experiment in a language they can understand. The participants' participation was completely voluntary and they had the liberty to leave the experiment at any point of time without any consequences.

3. RESULTS

3.1 Demographic Profile

The participants mean age was 46.47 ± 13.04 years, showing that varicose veins affect patients mainly at middle age. Males made up 63.3% of the study group, whereas females formed 36.7% of the study group. Workers in health care and teaching fields constituted the highest proportion in occupation, each being 26.7%. Table 1 displays specifics of the research subjects' demographic profile.

Table 1. Demographic Profile

Variable	Frequency (%) / Mean ± SD
Age (years)	46.47 ± 13.04
Male	38 (63.3)
Female	22 (36.7)
Farmer	8 (13.3)
Healthcare Worker	16 (26.7)
Manual Laborer	6 (10.0)
Office Worker	8 (13.3)
Shopkeeper	6 (10.0)
Teacher	16 (26.7)

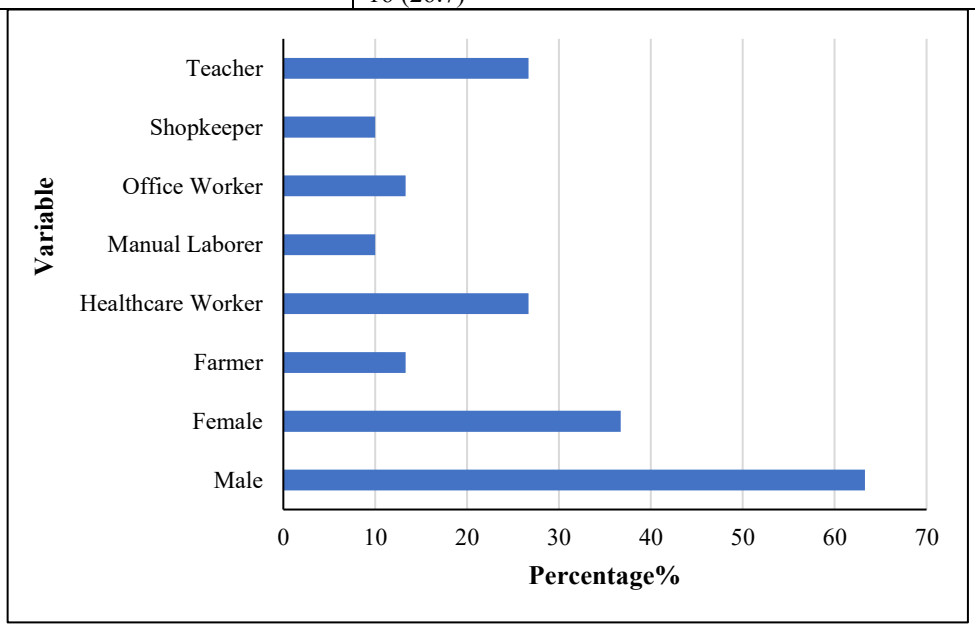

Figure 3. Distribution of Study Subjects According to Sex and Occupation

Figure 3 represents the distribution of participants of the study by gender and profession. There were more male participants in the study population than females, and there were participants of various occupations. The occupations having more numbers of participants in the study were health care professionals and teachers.

3.2 Venous Doppler Characteristics

Doppler examination of the veins showed the LSV to be the most commonly affected vein system, comprising 68.3% of all cases. Sapheno-femoral incompetency was seen in 56.7%, whereas sapheno-popliteal incompetency occurred in 41.7%. Incompetent perforators were seen in 38.3% of the subjects undergoing the study. The findings from Doppler examination have been illustrated in Table 2.

Table 2. Venous Doppler Features

Variable	Frequency (n)	Percentage (%)
System of Venous Involvement		
Long Saphenous Vein (LSV)	41	68.3
Short Saphenous Vein (SSV)	10	16.7
Both Systems	9	15.0
SFJ Competency		
Competent	26	43.3
Incompetent	34	56.7
SPJ Competency		
Competent	35	58.3
Incompetent	25	41.7
Perforator Competency		
Competent	37	61.7
Incompetent	23	38.3

3.3 Distribution of Venous Reflux Severity

The analysis of reflux time showed that grade II reflux constituted the largest number of refluxes, 51.7%. Grade III reflux was noted in 28.3%, and grade I refluxs comprised 20.0% of the patients. Thus, it can be concluded that the most of refluxes among the studied patients were of a moderate degree of severity (Table 3).

Table 3. Reflux Grade Distribution

Reflux Grade	(n)	(%)
Grade I	12	20.0
Grade II	31	51.7
Grade III	17	28.3
Total	60	100.0

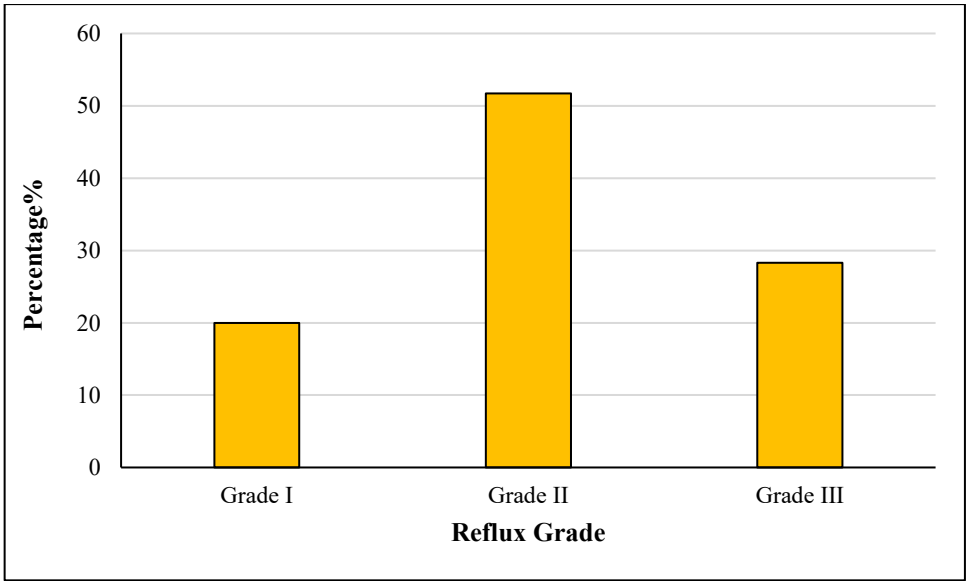

Figure 4. Distribution of Study Subjects

Figure 4 illustrates the distribution of participants in the study based on the grade of venous reflux, as determined using Doppler ultrasound. The group with moderate reflux was more commonly seen than the group with severe reflux, but mild reflux had the least representation, signifying that there was a preponderance of significant venous reflux.

3.4 Mean Reflux Duration, Clinical Severity, and Disability Scores

Participants had a mean reflux duration of 1.00 ± 0.638 seconds. A mean score of 14.95 ± 6.828 was observed for the VCSS, signifying moderate disease severity, whereas a mean Venous Disability Score (VDS) of 1.67 ± 0.914 signified moderate disability. These results offer an overview of the burden of disease and have been illustrated in Table 4.

Table 4. Mean Reflux Duration, VCSS and VDS Scores

Variable	Mean ± SD
Reflux Duration (seconds)	1.00 ± 0.638
VCSS	14.95 ± 6.828
VDS	1.67 ± 0.914

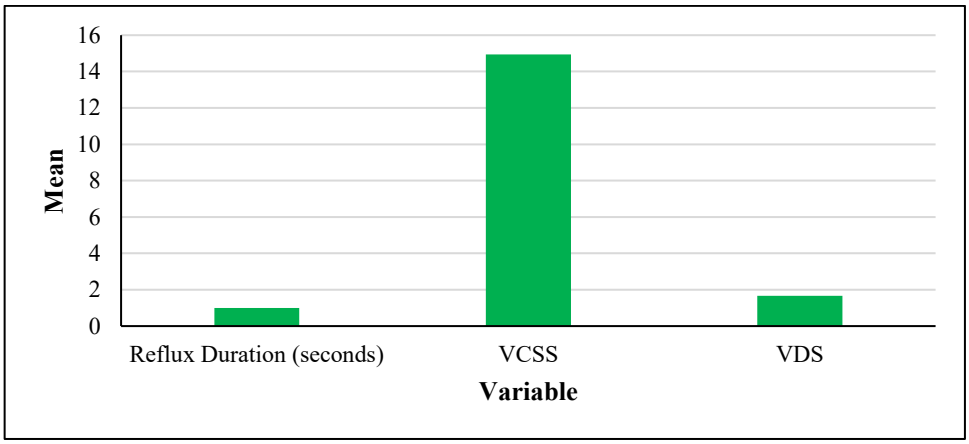

Figure 5. Mean Reflux Duration, VCSS, and VDS Among Study Subjects

Figure 5 depicts the average time for reflux, VCSS, and VDS in the subjects. This figure shows a summary of disease severity and disability of the subjects, demonstrating the correlation between the Doppler studies and the other clinical evaluation tests.

3.5 Correlation Among Venous Reflux Grade and Clinical Severity

VCSS values showed an increase with advancing reflux grade levels, varying from 6.25 ± 1.76 for Grade I reflux to 24.12 ± 2.96 for Grade III reflux. A statistically substantial alteration was observed between the different groups for VCSS using one-way ANOVA ($F = 210.23$; $p < 0.001$). In adding, there was a highly substantial positive correlation among reflux grade and VCSS ($r = 0.914$; $p < 0.001$), as displayed in Table 5 below.

Table 5. Correlation Among Reflux Grade and VCSS

Reflux Grade	n	Mean VCSS ± SD
Grade I	12	6.25 ± 1.76
Grade II	31	13.29 ± 2.27
Grade III	17	24.12 ± 2.96

One-way ANOVA: $F = 210.23$, $p < 0.001$, Spearman Correlation: $r = 0.914$, $p < 0.001$

3.6 Correlation Between Venous Reflux Grade and Functional Disability

Similarly, there was a gradual increase in VDS scores from 0.50 ± 0.52 in Grade I reflux to 2.71 ± 0.47 in Grade III reflux. One-way ANOVA showed significant differences across different reflux grades ($F = 70.47$, $p < 0.001$). The correlation examination using Spearman's rho correlation coefficient showed that reflux grade had a significantly favourable correlation with VDS scores ($r = 0.835$, $p < 0.001$) as shown in Table 6.

Table 6. Correlation Among Reflux Grade and VDS

Reflux Grade	n	Mean VDS ± SD
Grade I	12	0.50 ± 0.52
Grade II	31	1.55 ± 0.51
Grade III	17	2.71 ± 0.47

One-way ANOVA: $F = 70.47$, $p < 0.001$, Spearman Correlation: $r = 0.835$, $p < 0.001$

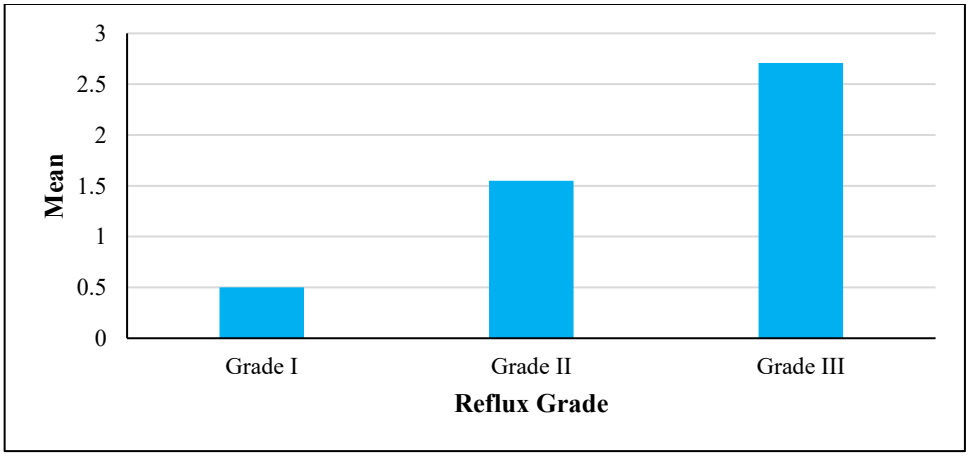

Figure 6. Relationship Between Venous Reflux Grade and VDS

Figure 6 shows the difference in the VDS among various classes of venous reflux. There is a trend in the increase of the disability scores along with an increase in reflux severity. Figure 5 clearly indicates that higher degrees of reflux detected by Doppler are related to increased physical limitation.

3.7 Association of Doppler Characteristics with Severe Reflux

Further analysis of the correlation between severe reflux and some Doppler parameters was undertaken. Though severe reflux occurred significantly more often in cases with SFJ incompetence, the results were not statistically significant ($\chi^2 = 1.16$; $p = 0.280$). Perforator incompetence and severe reflux also did not demonstrate any statistical association ($\chi^2 = 1.41$; $p = 0.235$) (Table 7).

Table 7. Association of SFJ and Perforator Incompetence with Severe Reflux

Variable	Grade I & II	Grade III	χ^2	p-value
SFJ Competent	21	5	1.16	0.280
SFJ Incompetent	22	12		
Perforator Competent	24	13	1.41	0.235
Perforator Incompetent	19	4		

3.8 Association of Severe Reflux with Clinical Severity and Disability

A very strong correlation existed between severe reflux and both clinical severity and disability. There was no case of grade III reflux among any patient having a VCSS <15 and/or VDS <2. On the other hand, there was grade III reflux in all patients having VCSS >14 and/or VDS >1. Both correlations had statistical significance; χ^2 for both VCSS and VDS was 27.88 and 15.76 correspondingly ($p<0.001$) (Table 8).

Table 8. Association of Severe Reflux with Clinical Severity and Functional Disability

Variable	Grade I & II	Grade III	χ^2	p-value
VCSS <15	34	0	27.88	<0.001
VCSS ≥15	9	17		
VDS <2	26	0	15.76	<0.001
VDS ≥2	17	17		

4. DISCUSSION

In this current study, the correlation between the Doppler grading of venous reflux or the clinical presentation of varicose veins patients was studied. It was found that the greater the reflux severity, the higher were the VCSS and VDS. Grade II was the commonest grade for venous reflux, and grade III venous reflux was found to be associated with clinical severity and functional disabilities.

The majority of the subjects studied were middle-aged patients, with men being more prone to the condition. A high percentage of healthcare practitioners and teachers were found among those suffering from the disease, which may be attributed to their standing occupations. Doppler ultrasonography confirmed the presence of the long saphenous vein segment, along with incompetent saphenofemoral junctions. There is a positive correlation between the reflux grade and VCSS score, meaning that higher degrees of reflux lead to more severe manifestations of disease. Likewise, there is a positive relationship between the reflux grade and the VDS score, showing the impact of reflux degree on functional impairment of patients.

The results obtained in the current research are in agreement with earlier studies. Singh, A.K. et al. (2020) concluded that reflux duration and peak reflux velocity can be used as parameters to quantify the severity of superficial venous reflux. Singh, M. et al. (2020) found that there is a statistically substantial connotation between the great saphenous vein's size and reflux or varicosity formation. Yang et al. (2021) found significant associations between vein size, reflux parameters, and severity of the disease. Yılmaz et al. (2021) found that extended reflux patterns correlated with higher disease severity. According to Tan et al. (2024), anatomy-based reflux patterns are essential in disease diagnosis and treatment planning. Viljamaa et al. (2023) noted the significance of correctly identifying incompetent venous segments in treatment. On the other hand, Zhang et al. (2023) showed the increasing importance of modern vascular imaging in diagnosing vascular diseases.

These results hold substantial significance from a clinical standpoint. The correlations between reflux grading, VCSS, and VDS indicate that venous Doppler ultrasonography can be employed as a reliable means of evaluating disease severity and disability. The current study had several limitations due to its cross-sectional nature, being conducted at a single institution and having a minor number of patients. Moreover, the results regarding treatment efficacy and long-term follow-up were not analyzed. Multicenter longitudinal trials involving larger cohorts are required to determine the prognostic value of reflux grading.

On the whole, a significant correlation between clinical and venous reflux severity and functional disability was found in this study. The results obtained can serve as scientific evidence of the clinical significance of venous Doppler ultrasonography for diagnosing varicose veins.

5. CONCLUSION

The outcomes of the current research showed that there is an association between venous reflux severity, which was evaluated with Doppler ultrasonography, and clinical severity in varicose vein patients. The increasing grades of venous

reflux resulted in increasing VCSS and VDS, implying that as the severity of hemodynamic disorders increased, clinical features also became more severe. In this study, grade II venous reflux was observed as the most prevalent group, whereas grade III was seen as the most severe. The usefulness of the Doppler Ultrasound in the objective evaluation of reflux presence, pattern of involvement, as well as competence of the junctional/perforators veins was noted. The relation between the grade of reflux and the scores on the VCSS and VDS scales was positive and significant, which shows that the clinical significance of the assessment of reflux presence with the aid of Doppler Ultrasound can be considered high. The obtained results allow assuming that reflux grade is rather informative in terms of providing additional information about the degree of venous pathology and the functional impairment of the patient. It has been concluded that the combination of the Doppler Ultrasound and clinical scales like VCSS and VDS could be applied in treating varicose veins.

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