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Comparative Analysis of Great Saphenous Vein and Small Saphenous Vein Diameters: Effects of Position and CEAP Scoring: Protocol

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ABSTRACT

Background: Chronic venous insufficiency (CVI) is a prevalent vascular disorder characterized by venous hypertension, varicose veins, edema, and ulceration. Duplex ultrasonography is the primary diagnostic modality; however, supine imaging underestimates vein diameters due to minimal hydrostatic pressure. Posture-specific assessment of great saphenous vein (GSV) and small saphenous vein (SSV) diameters may better reflect clinical severity as graded by CEAP (Clinical, Etiological, Anatomical, Pathophysiological) classification.

Objective: To compare GSV and SSV diameters in standing versus supine positions and assess correlations with CEAP clinical scores in patients with CVI.

Methods: A prospective cross-sectional study will include approximately 370 adult patients presenting with symptomatic venous disease. Duplex ultrasonography (7–10 MHz linear probe) will record segmental diameters of GSV and SSV in both postures. Measurements will be correlated with CEAP (C) grading. Statistical analysis will include paired t-tests/Wilcoxon tests, Pearson/Spearman correlation, and ROC curve analysis to define posture-specific diagnostic thresholds.

Expected Outcomes: Standing-position measurements are expected to yield larger diameters and stronger correlations with CEAP grades. Results will support the development of posture-adjusted diagnostic standards for early and accurate CVI management.

KEYWORDS: Chronic venous insufficiency, Great saphenous vein, Small saphenous vein, Doppler ultrasound, CEAP classification, Varicose veins

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INTRODUCTION

Background

Chronic venous disease (CVD) represents a broad spectrum of venous pathologies, ranging from minor telangiectasias and reticular veins to advanced manifestations such as varicosities, edema, skin pigmentation, lipodermatosclerosis, and venous ulcers. The underlying pathophysiology is predominantly related to venous valve incompetence or venous obstruction, leading to elevated hydrostatic pressure within the superficial and deep venous systems and impaired venous return. This chronic venous hypertension contributes to venous wall remodeling, inflammation, and progressive deterioration of venous function, culminating in the diverse clinical manifestations observed in CVD [1,2].

CVD is a common condition globally, with prevalence estimates ranging from 25% to 33%, and it imposes substantial health, social, and economic burdens. Patients experience physical discomfort, cosmetic concerns, and impaired quality of life, while healthcare systems face increased costs associated with long-term management, recurrent complications, and surgical interventions [1,2]. Despite its high prevalence, early detection and stratification of disease severity remain challenging, highlighting the need for reliable diagnostic markers.

Duplex ultrasonography has emerged as the gold standard for noninvasive evaluation of venous anatomy, valve competence, and reflux, as well as for quantifying vein diameters. Multiple studies have demonstrated that vein diameter is a critical predictor of reflux and disease progression. For example, in a Korean cohort, reflux was associated with great saphenous vein (GSV) diameters ≥5.05 mm and small saphenous vein (SSV) diameters ≥3.55 mm [3], whereas a Turkish population reported higher thresholds, with GSV ≥5.35 mm and SSV ≥4.85 mm [4]. These variations underscore the influence of ethnicity, genetic factors, and environmental conditions on venous anatomy and pathophysiology. Additionally, regional differences along the course of the GSV may correlate with localized reflux risk, suggesting the importance of site-specific assessment [5].

An important yet often underappreciated factor in venous assessment is posture. Venous diameters are highly dynamic and influenced by hydrostatic pressure; supine measurements tend to underestimate true vein calibers due to the absence of

gravitational distension, while standing measurements more accurately reflect physiologic venous filling. Posture-dependent changes in vein diameter have been correlated with the clinical severity of CVD, as graded by the CEAP (Clinical-Etiological-Anatomical-Pathophysiological) classification, indicating that upright assessments may improve the predictive accuracy for reflux and disease progression [6,7].

Despite these insights, there remains a notable gap in standardized, posture-specific data correlating GSV and SSV diameters with CEAP grades, particularly in the Indian population. Most existing studies are limited to European or East Asian cohorts, and extrapolation to Indian patients may not accurately reflect anatomical and pathophysiological variations influenced by ethnicity, lifestyle, and environmental factors. Addressing this gap is crucial for developing population-specific diagnostic thresholds, guiding clinical decision-making, and optimizing patient management. This study therefore aims to comprehensively evaluate posture-dependent GSV and SSV diameters in relation to CEAP clinical scores among Indian patients with CVD, thereby contributing to a more precise and clinically relevant understanding of venous disease in this population

RATIONALE

Diagnostic variability stems from inconsistent measurement postures and non-standardised interpretation of venous diameters. This limits comparison across studies and hampers the creation of unified diagnostic criteria. Establishing posture-specific cut-off values for GSV and SSV diameters, and validating their relationship with CEAP clinical grades, can enhance diagnostic precision and enable early therapeutic decisions. The present study aims to generate objective data that integrate duplex imaging parameters with clinical scoring to refine assessment of chronic venous insufficiency.

AIM & OBJECTIVES

Aim

Compare GSV and SSV diameters in standing versus supine positions and assess correlation with CEAP clinical grades.

Objectives:

To measure segmental GSV and SSV diameters at predefined anatomical sites.

To correlate segmental diameters with CEAP (C) scoring.

To identify posture-specific diagnostic thresholds for venous dilation.

To provide guidance for integrating posture-specific duplex findings into CEAP-based evaluation.

Hypotheses:

Standing-position measurements will yield significantly larger diameters than supine measurements [6,7].

Standing-position diameters will correlate more strongly with CEAP clinical grades [3,5].

Methods

Study Design and Setting

Prospective, cross-sectional observational study.

Location: Department of Anatomy, JNMC, DMIHER (DU), Wardha.

Duration: 3 years (2022–2025).

Population

Adults ≥18 years presenting with symptoms suggestive of venous insufficiency (leg heaviness, pain, cramps, edema, pigmentation, or ulceration).

Inclusion Criteria:

Age ≥18 years

CEAP class C1–C6

Exclusion Criteria:

Prior/current DVT or chronic venous occlusion

Limb deformity or orthopedic implant

Non-venous systemic edema or pregnancy

Sample Size

Using prevalence p = 0.40, Z = 1.96 (95% CI), margin of error d = 0.05:

$$n = \frac{1.96^2 \times 0.4 \times 0.6}{0.05^2} \approx 370$$

Measurement Protocol

Duplex ultrasonography (Hitachi Aloka Arietta 65, 7–10 MHz linear probe).

GSV sites: upper thigh (~5 cm distal to SFJ), mid-thigh, lower thigh, below-knee, mid-calf, 10 cm above ankle.

SSV sites: just below knee, mid-calf, 10 cm above ankle.

Procedure

Clinical evaluation with CEAP (C) grading [8, 9].

Ultrasound in supine posture at rest.

Participants walk 10 minutes to induce orthostatic venous filling; repeat measurements in standing posture [6,7].

Data recorded in standardized proforma.

DVT or chronic obstruction excluded before enrolment.

Measurements performed in temperature-controlled room to avoid venospasm.[10]

Data Analysis

SPSS v25.0.

Paired t-tests or Wilcoxon signed-rank tests for posture comparison.

Pearson/Spearman correlation for diameter–CEAP associations.

ROC analysis to determine optimal posture-specific cut-offs.

Statistical significance: $p < 0.05$.

Ethical Considerations

Approved by Institutional Ethics Committee, DMIHER (DU), Wardha.

Written informed consent obtained; confidentiality preserved.

Protocol follows Declaration of Helsinki.

Expected Outcomes

Standing-position diameters expected to exceed supine measurements.

Stronger correlation of standing diameters with CEAP clinical grades.

Posture-specific diagnostic thresholds for GSV and SSV established.

Improved clinical decision-making, early intervention, and potential reduction in morbidity and healthcare costs [3,4,6,7].

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