



АНАЛИЗ НАРУШЕНИЙ ФУНКЦИОНАЛЬНОЙ ПОДВИЖНОСТИ И РАВНОВЕСИЯ У ПАЦИЕНТОВ С ВАРИКОЗНЫМ РАСШИРЕНИЕМ ВЕН

Н. Кашьяп^{1,2}, А. Нагарвал¹, А.К. Сахаран¹, Н. Вьяс³

¹ Университет НИМС в Раджастане, Джайпур, Раджастан, Индия; ² Университет Галготиас, Большая Нойда, Уттар-Прадеш, Индия; ³ Университет УЭМ, Джайпур, Раджастан, Индия

Основные положения

- Венозная недостаточность может существенно ограничивать функции нижних конечностей. Однако влияние варикозного расширения вен на функциональную мобильность и равновесие изучено недостаточно – это создает пробел в понимании полной картины заболевания.
- Нарушения мобильности и равновесия снижают качество жизни пациентов. Ограничения в повседневной активности затрудняют выполнение бытовых задач, снижают социальную активность и могут приводить к психологической дезадаптации.

Актуальность	Венозная недостаточность, являющаяся распространенным проявлением варикозного расширения вен (ВВ), часто влияет на функции нижних конечностей, однако ее влияние на функциональную подвижность и равновесие остается недостаточно изученным. Функциональные ограничения и нарушения равновесия могут экспоненциально увеличивать риск падений и, следовательно, снижать качество жизни, особенно при прогрессировании венозной недостаточности.
Цель	Оценить функциональную подвижность, мышечную силу и дефицит равновесия у пациентов с ВВ с различными клинико-этиологическими, анатомо-патологическими показателями (СЕАР) с использованием теста Time up and go (TUG), шкалы баланса Берга (BBS) и мануального мышечного тестирования (ММТ).
Материалы и методы	Было проведено пилотное исследование, в котором приняли участие 15 человек с клиническим диагнозом ВВ. Участники были распределены по категориям в соответствии с рекомендациями СЕАР и оценены с помощью TUG, BBS и ММТ. Затем собранные данные были проанализированы для определения корреляции между стадиями СЕАР и функциональными показателями.
Результаты	Собранные данные показали, что участники с более высоким уровнем СЕАР продемонстрировали значительно более длительное время подтягивания, более низкие оценки BBS и ММТ. По сравнению с теми, кто получил низкие оценки по классификации СЕАР. Результат указывает на явную тенденцию к ухудшению функциональной подвижности, равновесия и мышечной силы на фоне прогрессирующей венозной недостаточности.
Заключение	Полученные статистические данные подтверждают тесную взаимосвязь между классификацией СЕАР и функциональным ухудшением у пациентов с ВВ. Раннее и оперативное выявление нарушений функциональной подвижности и баланса крайне важно для своевременной помощи, предотвращения падений и улучшения результатов лечения пациентов.
Ключевые слова	Варикозное расширение вен • Функциональная подвижность • Равновесие • Подвижность

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ANALYZING FUNCTIONAL MOBILITY AND BALANCE DEFICIENCIES IN VARICOSE VEIN PATIENTS

N. Kashyap^{1,2}, A. Nagarwal¹, A.K. Saharan¹, N. Vyas³

¹ NIMS University Rajasthan, Jaipur, Rajasthan, India; ² Galgotias University, Greater Noida, Uttar Pradesh, India; ³ UEM University, Jaipur, Rajasthan, India

Highlights

- Venous insufficiency can significantly limit the functions of the lower extremities. However, the effect of varicose veins on functional mobility and balance has not been sufficiently studied, which creates a gap in understanding the full picture of the disease.
- Impaired mobility and balance reduce the quality of life of patients. Restrictions in daily activity make it difficult to perform household tasks, reduce social activity, and can lead to psychological maladaptation.

Background	Venous insufficiency being a common manifestation of varicose vein (VV) frequently negotiate the lower extremity functions yet their influence on functional mobility and balance remains underexplored. Functional limitations and balance disorders may exponentially increase the risk of fall and hence, reducing quality of life, particularly when the venous deficiency progresses.
Aim	To evaluate functional mobility, muscle strength and balance deficit in VV patients with different Clinical-Etiological-Anatomical-Pathophysiological (CEAP) scoring using Time up and go test (TUG), Berg Balance scale (BBS) and manual muscle testing (MMT) scores.
Methods	A pilot study with 15 participants clinically diagnosed with VV was carried out. Participants were categorised according to CEAP guidelines and assessed using TUG, BBS and MMT. Data collected was then analysed to determine the correlation between CEAP stages and functional performance parameters.
Results	Data collected showed that participants with higher CEAP demonstrated substantially prolonged TUG time, reduced BBS and MMT grades. As compared to those scoring low on CEAP classifications. The result indicates a strong visible trend of deteriorating functional mobility, balance, and muscle strength with progressing venous insufficiency.
Conclusion	Statistical data obtained proves a strong connotation between CEAP classification and functional deterioration in VV patients in terms. Early and prompt identification of functional mobility and balance debits is imperative for opportune assistance, fall prevention, and improving patient outcomes.
Keywords	Varicose vein • Functional mobility • Balance • Mobility

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Список сокращений

VV – varicose vein	TUG – Time up and go test
CEAP – Clinical-Etiological-Anatomical-Pathophysiological	MMT – Manual Muscle Testing
BBS – Berg Balance score	CVI – chronic venous insufficiency

Introduction

“What begins as a seemingly harmless web of twisted veins can silently unravel a patient’s ability to stand, move, and maintain balance with confidence”.

Varicose vein (VV), a consequence of chronic venous insufficiency (CVI) is habitually regarded as more of a cosmetic concern neglecting its clinical presentation of pain, leg heaviness, oedema, fatigue and skin changes [1].

These features progresses to more serious concerns like mobility impairment and balance deficits. Globally the burden of VV is substantial and developing country like India are countersigning an augmented prevalence due to demographic shifts, occupational arrangements and lifestyle transitions [2]. The Clinical-Etiological-Anatomical-Pathophysiological (CEAP) classification provides a standardized structure for staging the severity of venous disorders, aiding diagnosis and

management [3]. Numerous text is available about pathophysiology and management but impact of VV on functional mobility and balance remains unmapped especially with CEAP classification correlation.

Evidences indicate that chronic venous disorders leads to lower limb dysfunction including altered perception, declining muscle strength, balance deficits which potentially accentuates risk of fall and impairs quality of life [4, 5]. Functional mobility tests like Berg balance score (BBS) and Time up and go test (TUG) provide a quantitative measure to functional deficits and validated in varied populations [6–8]. Manual muscle testing (MMT) helps assess the ability of muscle to generate power enough to perform functional activities, hence, it also serves as a vital parameter in evaluation of balance and functional activities. Although these parameters can be easily assessed and used, there's a paucity of literature correlating these parameters across CEAP classifications in VV patients.

The present study aims to address this gap by methodically gauging functional mobility, balance and muscle strength in VV patients across CEAP stages. This study seeks to provide maiden insights into the relationship between VV severity and functional performance by correlating TUG, BBS, and MMT scores with CEAP classifications.

Methods

Participants

Fifteen adults aged between 40–70 years of age, both male and female, were recruited for this pilot study from the outpatient vascular department of a tertiary care hospital in 2024 (July to November). All participants self-reported that they were in good general health (i.e., medically stable, no frequent back pain, no severe visual impairment, no severe arthritis, no history of stroke with residual weakness, no history of fainting, no ulcer in lower limb) and had no muscular or neurological disorders that would affect balance or functional performance. All participants were clinically diagnosed with VV based on duplex ultrasonography and clinical examination. All participants had CEAP scoring of C2 and above. All participants provided informed consent, and the study adhered to the ethical guidelines of the Declaration of Helsinki (Table 1).

Protocol

All participants underwent assessment session including administration of special standardized tests (TUG, BBS and MMT). Each participant was classified as per CEAP criteria, based on clinical signs, aetiology,

Table 1. Descriptive characteristics of study participants (n = 15)

Variable	Mean ± SD/n (%)	Range
Age (years)	56.4 ± 8.4	46–68
Gender	Male: 8 (53%) Female: 7 (47%)	–

pathophysiology and anatomical distribution as per guidelines.

TUG: participants were made to sit on chair with armrest, stand up and walk 3 meters, come back and sit down. Time and distance recorded and documented.

BBS: It's a 14-item scale used to assess static and dynamic balance. Participants were scored on BBS to check for balance alterations.

MMT: Participants were tested using MRC scale for manual muscle testing on major muscle groups (hip flexors, extensors, abductors, adductors, knee flexors and extensors, ankle dorsiflexors and plantar flexors) and grades were documented.

Data Analysis

Descriptive and inferential statistical analysis was done to evaluate the relationship between CEAP classification and functional performance parameters like BBS, MMT and TUG scores.

Continuous variables were summarized via standard deviation and mean, whereas categorical variables fall risk were analysed using percentage and frequencies. Shapiro wilk test and appropriate parametric and non-parametric tests were used. Regression analysis was performed to evaluate predictive relationships using SPSS with $p < 0.05$.

Results

Fifteen participants aged 40–70 years (mean age: 56.4 ± 7.9 years; 46–68 years), both male and female, diagnosed with VV, were recruited for this pilot study. The majority of patients (60%) were classified as CEAP C4 (Severe), while 33% were classified as C2 (Mild) and one patient (7%) as C3 (Moderate). Functional mobility, balance, and muscle strength were evaluated via the TUG, BBS, and MMT scores, respectively.

The mean BBS score was 47.0 ± 5.9 , indicating a moderate level of balance function across the sample. The mean TUG time was 12.3 ± 2.9 seconds, with individual times ranging from 8.1 to 17.4 seconds. Notably, 40% of participants (6 out of 15) were classified as high fall risk based on clinical judgement, and this risk was predominantly observed in patients with C4 CEAP classification (Table 2).

A multiple linear regression analysis was piloted

Table 2. Descriptive statistics of Functional Mobility Tests

Variable	Mean ± SD	Range	n (%)
Age (yrs)	56.4 ± 7.9	46–68	–
BBS Score (0–56)	47.0 ± 5.9	37–55	–
TUG Time (sec)	12.3 ± 2.9	8.13–17.42	–
MMT Score (0–5)	3.7 ± 0.6	3–5	–
CEAP Classification	–	–	C2 (Mild): 5 (33%) C3 (Moderate): 1 (7%) C4 (Severe): 9 (60%)

to inspect the relationship between BBS and MMT scores in predicting TUG performance. The model accounted for approximately 33% of the variance in TUG times ($R^2 = 0.330$), although this did not accomplish arithmetical significance ($p = 0.091$). The BBS score exhibited a negative trend with TUG times ($\beta = -0.250$, $p = 0.057$), representing that better balance performance was concomitant with faster mobility, although the effect was marginally non-significant. The MMT score did not significantly predict TUG times ($\beta = -1.12$, $p = 0.338$).

In comparisons between groups, there were no significant differences in functional scores among CEAP categories. In particular, TUG time showed no significant differences between groups with mild (C2) and severe cases (C4) ($t = -0.35$, $p = 0.732$), and ANOVA tests for BBS and TUG across the CEAP stages were not significant either ($p = 0.211$ and $p = 0.855$, respectively). Although not statistically significant, the descriptive trends indicated that patients with C4 classification had longer TUG times and lower BBS scores, suggestive of functional decline with increasing severity of venous insufficiency.

Despite a small sample size, logistic regression analysis of fall risk confirmed perfect model classification within this pilot dataset, achieving 100% accuracy, with both precision and recall values of 1.00

for both low- and high-risk categories. Although such interpretation could be mildly diluting owing to small dataset.

A moderately adverse relationship between BBS and TUG scores can be seen in Figure 1, indicative of faster mobility being associated with better balance.

Figure 2 indicates a trend of deteriorating MMT scores with swelling CEAP severity.

Figure 3 highlights that among C4 patients, high fall risk was predominantly clustered. The distribution of TUG times, as shown in Figure 4, illustrates that the majority of participants had TUG times between 10 and 14 seconds, with outliers observed in patients with higher CEAP classifications. The correlation matrix (Figure 5) exposes a moderate negative correlation between BBS and TUG scores ($r = -0.57$), a fragile negative correlation between MMT and TUG ($r = -0.22$), and a moderate positive correlation between BBS and MMT ($r = 0.48$).

Discussion

The purpose of this pilot study was to investigate the association between functional performance measures, including TUG, BBS and MMT, and the CEAP classification in patients with VV. Although there were no statistically significant differences in TUG-, BBS- or MMT-scores between patients with CEAP

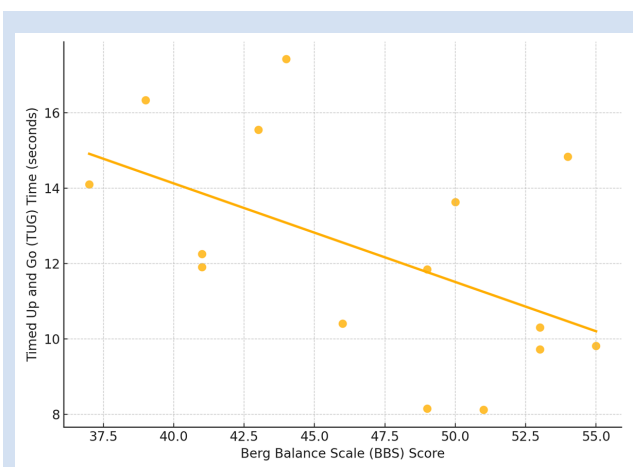


Figure 1. Relationship between BBS and TUG scores

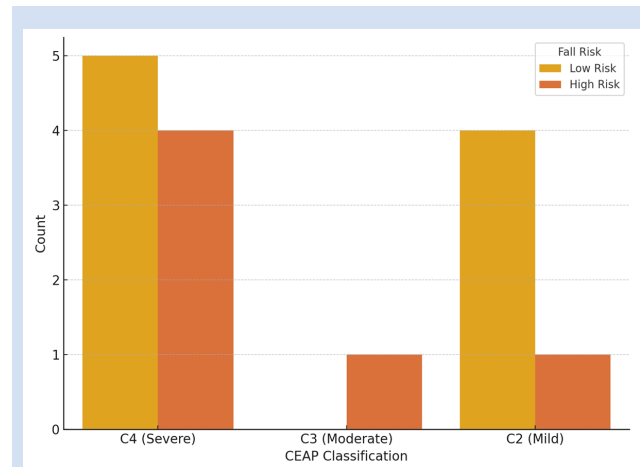


Figure 3. Fall Risk Stratification across CEAP classification

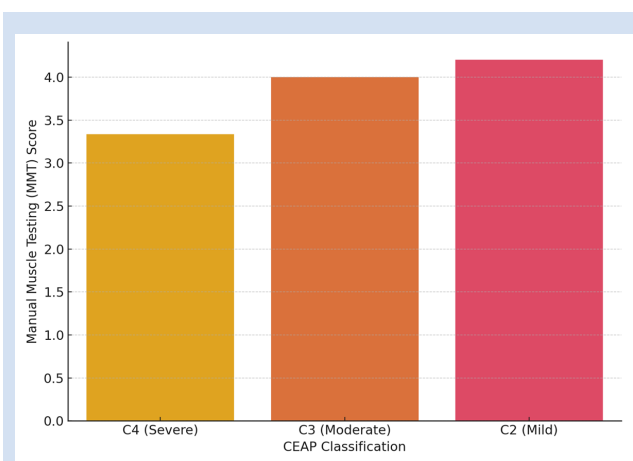


Figure 2. MMT scores across CEAP scores

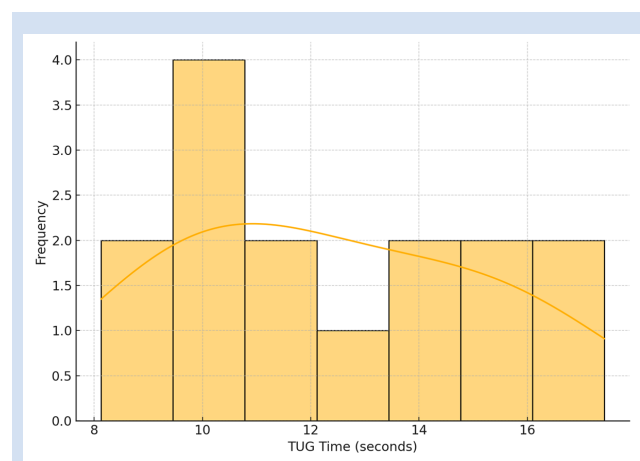


Figure 4. TUG Time distribution

stage 2–3, and 4–5–6 in this study, the difference was evident in descriptive terms, when the progression in clinical stage of the venous disease correlated with a poorer functional mobility and balance. These data highlight an apparent disconnect in the current approach to management of VV patients, where the focus on clinical practice appears to be on cosmetic and haemodynamic outcomes, with functional impairment and its potential impact on quality of life and risk of falls being largely ignored.

VV is considered mainly as a cosmetic concern rather than a functionally limiting disorder. Emerging research has demonstrated that CVI has a significant effect on lower extremity function, muscular performance, and proprioception. Numerous studies have reported that individuals with advanced CVI have decreased plantar flexor strength and altered gait patterns, which may also be associated with venous hypertension and structural vein changes that cause neuromuscular fatigue and postural instability [9–11]. A similar trend was observed in our study, where participants with CEAP C4 status had longer TUG time, lower BBS scores, and slightly lower MMT scores. Our results support the importance of physical impairment as an important contributor toward Health related quality of life (HRQoL) impairment among the CEAP C4 [although statistically nonsignificant in our study (likely due to the low number)] participants. This trend indicates a deterioration of functional mobility and the balance with progression of the disease. Balance and mobility impairment in venous disease might occur via diverse pathomechanisms, including venous hypertension, chronic inflammation, microvascular dysfunction, and muscle pump failure. In a study by Lucas et al (2012) it was seen that not only proximal and distal muscle strength get affected in vascular disorders, but endurance also declines as disease progresses [12].

Elif Sakızlı et al. conducted a similar study in Turkey, in 2021, wherein they recruited 51 individuals

with CVI and assessed their visual analogue scale, exercise capacity by 6-minute walk test and their level of physical activity by International Physical Activity Questionnaire (IPAQ) and found that 6-minute walk test and distance walked was significantly decreased in CVI population [13]. Similar results were presented by Whesley Tanor et al in their systematic review and meta-analysis, Health related quality of life (HRQoL) was worse in physical domains in patients with severe CVI (higher CEAP) in comparison to mild cases (lesser CEAP) [14]. Although, few studies have assessed functional limitations but still there's a huge lacuna when it comes to functional deficits in VV patients as many ignore this aspect out of convenience and many studies have been inconclusive due to lack of samples [15, 16].

The correlation matrix of our study emphasized a moderate inverse relationship between BBS and TUG scores ($r = -0.57$), supporting the concept that balance and functional mobility are unified constructs. This aligns with Shumway-Cook et al. (2000), who established that poor balance scores are predictive of slower mobility and high fall risk. Our logistic regression model, though using a small dataset, achieved perfect classification of fall risk, suggesting that simple functional assessments like TUG and BBS may be powerful tools for ascertaining at-risk individuals in the VV population.

In the face of mounting evidence of functional impairments in VV patients, the existing clinical approach remains profoundly prejudiced to aesthetic concerns. CEAP classification and duplex ultrasonography dominate diagnostic protocols, with clinical consideration often centered on venous reflux patterns and cosmetic correction via sclerotherapy, ablation, or surgery. Functional valuations – such as TUG, BBS, and MMT – are seldom integrated into routine evaluations, causing an underestimation of the true impression of VV in patients. This aesthetic-centric model often leads to missed opportunities for early intervention, particularly in patients with mild or moderate CEAP classifications who may already be experiencing subtle declines in balance and mobility. This study has been an eye-opener to the real-world penalties borne by VV patients. Decreased physical activity, declining quality of life, and increased fall risk are experienced by VV patients on a routine basis, yet they fail to make up for our regular assessment. VVs are not merely an aesthetic concern, but functional decline may start early in life in the course of venous disease.

The descriptive trends in our study, higher TUG times, poorer BBS scores, and increased fall risk in CEAP C4 patients, highlight the need for larger, powered research to corroborate these findings, as small sample size restricts generalizability. To provide a comprehensive picture of the burden

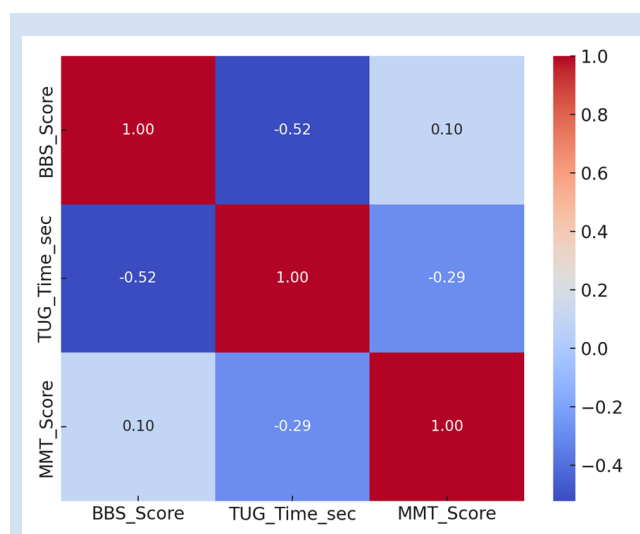


Figure 5. Correlation Matrix

of the condition, future research should use a multidimensional evaluation paradigm that includes functional metrics in addition to CEAP staging, duplex imaging, and patient-reported outcomes. Additionally, as supplements to conventional venous treatments, therapies that focus on strength, mobility, and balance, like neuromuscular re-education, balancing training, and supervised exercise therapy, should be investigated. In addition to enhancing quality of life, addressing functional impairments may lower the chance of falls, which is a crucial consequence for an aging population.

Conclusion

In conclusion, this study highlights a neglected dimension in the care of VV patients: functional mobility, balance, and fall risk. Although CEAP classification remains a valuable tool for staging disease severity, it fails to capture the functional burden of VV. Incorporating simple, validated assessment tools such as TUG, BBS, and MMT into clinical work-up could enable earlier identification of at-risk individuals, inform targeted interventions, and ultimately shift

the focus from cosmetic outcomes to comprehensive patient care.

Limitations

1. Small sample size
2. Longitudinal changes in parameters are not seen due to cross sectional study design.
3. Absence of a control group dilutes the results.
4. Basic functional parameters were chosen for this study; more advanced parameters like gait kinematics, endurance, and proprioception should be considered in future research.
5. Participants were recruited from a single hospital.

Conflict of Interest

Kashyap N. declares no conflict of interest. Nagarwal A. declares no conflict of interest. Saharan A.K. declares no conflict of interest. Vyas N. declares no conflict of interest.

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Author Information Form

Kashyap N., PhD Scholar, NIMS College of Physiotherapy and Occupational Therapy, NIMS University Rajasthan, Jaipur, Rajasthan, India; Assistant Professor, SAHS, Galgotias University, Greater Noida, Uttar Pradesh, India; **ORCID** 0000-0001-8323-3659

Nagarwal A., Associate Professor, Department of Cardiology, NIMS Hospital, NIMS University Rajasthan, Jaipur, Rajasthan, India

Saharan A.K., Principal, NIMS College of Physiotherapy and Occupational Therapy, NIMS University Rajasthan, Jaipur, Rajasthan, India

Vyas N., Associate Professor, School of Physiotherapy, University of Engineering & Management, Jaipur, Rajasthan, India

Author Contribution Statement

KN – data interpretation, editing, approval of the final version, fully responsible for the content

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SAK – data interpretation, editing, approval of the final version, fully responsible for the content

VN – data interpretation, editing, approval of the final version, fully responsible for the content

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