Original Research

ASSESSMENT OF ASYMPTOMATIC CAROTID ARTERY STENOSIS AMONG PATIENTS DIAGNOSED WITH PERIPHERAL ARTERY DISEASE

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ABSTRACT

Background: Peripheral arterial disease (PAD) is a manifestation of systemic atherosclerosis and is frequently associated with involvement of other vascular territories including the carotid arteries. Patients with PAD are at increased risk of asymptomatic carotid artery stenosis (ACAS), which may predispose them to ischemic stroke and cerebrovascular complications. The present study was conducted to determine the prevalence of ACAS in patients with PAD and evaluate associated risk factors.

Methodology: This hospital-based observational study was conducted in the Department of General Medicine at Sree Mookambika Institute of Medical Sciences from February 2025 to January 2026. Patients diagnosed with peripheral arterial disease based on ankle-brachial index (ABI) were included in the study. Carotid duplex ultrasonography was performed using a high-resolution B-mode ultrasound machine with a 7.5 MHz linear-array transducer to assess carotid artery stenosis and plaque characteristics. Clinical variables including age, smoking, diabetes mellitus, hypertension, chronic kidney disease, and coronary artery disease were analyzed. Statistical analysis was performed using Chi-square and Fisher's exact tests.

Results: A total of 147 patients were evaluated, with a mean age of 56 ± 9.72 years, and 87% were males. Smoking and hypertension were highly prevalent among study participants. Multilevel arterial disease was common. Advanced age (>63 years), chronic kidney disease, previous cerebrovascular disease, and ABI <0.4 showed significant association with severe carotid artery stenosis. Carotid duplex ultrasonography effectively identified significant asymptomatic carotid artery disease and vulnerable plaques.

Conclusion: Asymptomatic carotid artery stenosis is common among patients with peripheral arterial disease. Carotid duplex ultrasonography is a valuable non-invasive screening tool for early detection of carotid artery disease in high-risk PAD patients.

Keywords: Peripheral Arterial Disease, Asymptomatic Carotid Artery Stenosis, Carotid Duplex Ultrasonography, Atherosclerosis, Ankle-Brachial Index, Stroke Prevention.

INTRODUCTION

Atherosclerosis is a progressive systemic vascular disease affecting medium and large arteries throughout the body, including the coronary, peripheral, and cerebral circulation [1]. It is characterized by endothelial dysfunction, lipid deposition, inflammation, and plaque formation within arterial walls, leading to vascular narrowing and impaired blood flow. Atherosclerosis commonly involves multiple vascular beds simultaneously, and patients with disease in one arterial territory are at increased risk of involvement in other vascular regions.

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The coexistence of coronary artery disease, peripheral arterial disease (PAD), and carotid artery disease significantly increases morbidity and mortality due to cardiovascular and cerebrovascular complications [2].

Peripheral arterial disease is one of the major manifestations of systemic atherosclerosis and results from obstruction of blood flow in the arteries supplying the lower extremities. PAD is associated with reduced functional capacity, limb ischemia, and increased risk of myocardial infarction and stroke [3]. Several risk factors contribute to the development and progression of atherosclerosis and PAD, including advancing age, smoking, diabetes mellitus, hypertension, dyslipidemia, and obesity [4]. Among these, smoking and diabetes mellitus are considered particularly important contributors to both peripheral and carotid artery disease.

Carotid artery stenosis results from atherosclerotic narrowing of the extracranial carotid arteries and is an important risk factor for ischemic stroke [5].

Many patients with carotid artery disease remain asymptomatic until a cerebrovascular event occurs. Asymptomatic carotid artery stenosis (ACAS) refers to significant carotid artery narrowing in the absence of previous stroke or transient ischemic attack symptoms. Studies have demonstrated that the prevalence and severity of asymptomatic carotid artery stenosis are significantly higher among patients with peripheral arterial disease compared to the general population [6]. The presence of PAD may therefore serve as an indicator of generalized atherosclerosis and increased cerebrovascular risk.

Stroke remains a major cause of disability and mortality worldwide. Ischemic stroke accounts for nearly 74% of all stroke cases and is frequently associated with extracranial carotid artery atherosclerosis [7]. Epidemiological studies have reported crude stroke incidence rates ranging from 108 to 172 per 100,000 population annually, with significant one-month case fatality rates [8]. Early identification of asymptomatic carotid artery stenosis in high-risk populations such as PAD patients may therefore help reduce the burden of ischemic stroke through timely intervention and risk factor modification.

The Asymptomatic Carotid Atherosclerosis Study (ACAS) demonstrated that carotid endarterectomy significantly reduces the risk of stroke in selected asymptomatic patients with severe carotid artery stenosis greater than 60% [9]. Consequently, early diagnosis of carotid artery disease has gained considerable clinical importance. Carotid duplex ultrasonography is a safe, non-invasive, cost-effective, and highly accurate imaging modality used to detect carotid artery stenosis and evaluate plaque characteristics [10]. Although routine screening for carotid artery disease is not generally recommended in the overall population because of its relatively low prevalence, screening high-risk groups such as patients with peripheral arterial disease may be beneficial due to the increased prevalence of asymptomatic carotid stenosis in these individuals.

Several studies have emphasized the strong association between peripheral arterial disease and asymptomatic carotid artery stenosis, suggesting that PAD patients represent an important target population for carotid screening [11]. Detection of asymptomatic carotid stenosis may facilitate early preventive strategies, including aggressive medical management and surgical intervention when indicated, thereby reducing the risk of future cerebrovascular events.

Therefore, the present study was undertaken to evaluate the prevalence of asymptomatic carotid artery stenosis in patients with peripheral arterial disease and to assess the association between PAD and carotid artery involvement using carotid duplex ultrasonography.

Aim

To determine the prevalence of asymptomatic carotid artery stenosis in patients with peripheral arterial disease and evaluate its association with systemic atherosclerotic risk factors.

Objectives

1. To assess the prevalence of asymptomatic carotid artery stenosis among patients diagnosed with peripheral arterial disease.
2. To evaluate the severity of carotid artery stenosis using carotid duplex ultrasonography.
3. To study the association between peripheral arterial disease and carotid artery involvement.

MATERIALS AND METHODS

This hospital-based observational study was conducted in the Department of General Medicine at Sree Mookambika Institute of Medical Sciences during the period from February 2025 to January 2026. The study included patients diagnosed with peripheral arterial disease (PAD) who underwent evaluation and limb revascularization procedures during the study period. Patients with a history of neurological symptoms, previous stroke, previous carotid endarterectomy, emergency limb revascularization procedures, and PAD due to non-atherosclerotic causes were excluded from the study. Outpatients and claudicants managed conservatively on an outpatient basis were also excluded due to difficulty in follow-up.

Peripheral arterial disease was defined based on ankle-brachial index (ABI) values less than 0.90 or greater than 1.3. ABI was measured by dividing the higher ankle systolic pressure, obtained from either the dorsalis pedis or posterior tibial artery, by the higher brachial systolic pressure. The severity of PAD was assessed according to ABI measurements. Magnetic resonance angiography (MR angiogram) was performed to evaluate the distribution of arterial lesions, which were categorized as infra-inguinal lesions involving femoral and tibial vessels, supra-inguinal lesions involving iliac arteries and infrarenal abdominal aorta, and multilevel occlusive disease.

A total of 232 patients underwent limb revascularization during the study period. After applying exclusion criteria, eligible patients were enrolled in the study. Clinical characteristics including age, gender, smoking history, diabetes mellitus, coronary artery disease (CAD), chronic kidney disease (CKD), ankle-brachial index, severity of limb ischemia, and lesion distribution were recorded and analyzed.

All participants underwent carotid duplex ultrasonography using a high-resolution B-mode ultrasound machine (Hitachi EUB-525; Hitachi Medical Corporation, Tokyo, Japan) equipped with a 7.5 MHz linear-array transducer. Carotid vessels were evaluated for the presence, location, and

characteristics of atherosclerotic plaques as well as the degree of carotid artery stenosis. All ultrasonographic examinations were performed by a single experienced radiologist with more than 15 years of expertise in vascular ultrasonography. The severity of carotid artery stenosis was graded according to the Society of Radiologists in Ultrasound Consensus Conference guidelines and categorized into four groups: less than 50% stenosis, 50–69% stenosis, greater than 70% stenosis, and complete occlusion.

Plaque morphology was also assessed to identify unstable or vulnerable plaques based on ultrasonographic features. Vulnerable plaques were defined as plaques with a thin fibrous cap less than 100 µm and a large lipid core accounting for more than 40% of the plaque volume. Such plaques are considered highly prone to rupture and associated with increased risk of cerebrovascular events.

The collected data were entered into Microsoft Excel and analyzed using appropriate statistical software. Quantitative variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Statistical analysis was performed using Chi-square test and Fisher's exact test wherever appropriate to determine associations between peripheral arterial disease and asymptomatic carotid artery stenosis. A p-value of less than 0.05 was considered statistically significant.

RESULT

Among the 147 patients included in the study, the mean age was 56 ± 10 years, ranging from 51 years to 73 years. 87% patients (127/147) were male. 14% (20/147) patients had infra- inguinal disease and 49% (72/147) patients had multiple lesions.

Characteristics	**N = 147**
Mean Age , Years	56 ± 9.72
Gender , Male	127(87%)
Smoking	116(78%)
Hypertension	91(62%)
Diabetes Mellitus	69(47%)
Coronary Artery Disease (Cad)	10(7%)
Chronic Kidney Disease (Ckd)	4(3%)
Old Cerebrovascular Disease (Cvd)	3(2%)
Hyperlipidemia	9(6%)

Prevalence of ACAS based on PAD was found to be as stated below 109(74.14%) patients had < 50% stenosis, 16(10.80%) patients had between 50%-69% stenosis 17(11.56%) patients had >70% stenosis and 5(3.40%) patients were found to have an unstable plaque Patients with unstable plaque underwent carotid endarterectomy before limb revascularisation while the rest of the patients were managed appropriately after limb revascularisation. Prevalence of ACAS based on anatomical site of the peripheral arterial disease –

	Suprainguinal	Infrainguinal	Multiple
< 50%	18(90%)	45(81.8%)	46(63%)
50% – 69%	1(5)	5(9%)	10(13.8%)
>70%	1(5%)	5(9%)	11(15.2%)
Unstable Plaque	0	0	5(6.9%)

Combined lesions involving supra and infra-inguinal regions presented higher incidence of severe ICA stenosis (p = 0.016). Based on severity of PAD (by the measure of ABI), the distribution of ACAS patients was as follows

Abi*	50%– 69%	>70%	Unstable Plaque
0.7–0.89	2(P = 0.31)	2 (P = 0.33)	0
0. 5–0.69	6(P = 0.18)	4 (P = 0.21))	0
0. 4–0.49	8 (P = 0.06)	4 (P =0.21)	1
< 0.4	0	**7 (P = 0.04)**	**4 (P = 0.03)**

*in patients with both lower limb involvement, lower ABI among both limbs was considered ABI < 0.4 ,which signifies severe form of PAD is significantly associated with ACAS ,which implies positive correlation between severity of PAD and ACAS as well as the severity of carotid stenosis.

Analysis of individual risk factors for severity of ICA stenosis in PAD patients on a multivariate analysis the following risk factors were found to have significant association with severity of carotid artery stenosis.

	Confidence Index	Odds Ratio	*P* Value
Age > 63	1.02 – 1.14	1.061	**0.031**
Diabetes Mellitus	0.55 – 3.10	1.360	0.339
Hypertension	0.24 – 1.30	0.530	0.421
Smoking	0.31 – 2.21	0.860	0.752
CKD	1.13 – 16.42	9.370	**0.0129**
CAD	0.23- 10.11	1.540	0.352
H/O Stroke	1.08-15.89	3.972	**0.036**

Age > 63 years, Old CVD, CKD and ABI < 0.4 were found to have significant association with the severity of CAS.

DISCUSSION

The present study evaluated the prevalence and severity of asymptomatic carotid artery stenosis (ACAS) in patients with peripheral arterial disease (PAD) and analyzed associated risk factors. The findings demonstrated a significant association between peripheral arterial disease and carotid artery involvement, supporting the concept that atherosclerosis is a systemic vascular disorder affecting multiple arterial territories simultaneously. In the current study, the mean age of patients was 56 ± 9.72 years, and the majority of patients were males (87%). Similar demographic patterns have been reported in previous studies where PAD and carotid artery disease were more prevalent among elderly male populations due to increased exposure to atherosclerotic risk factors such as smoking, hypertension, and diabetes mellitus [12]. Smoking was observed in 78% of patients, emphasizing its major contribution to the development and progression of systemic atherosclerosis. Cigarette smoking causes endothelial dysfunction, oxidative stress, inflammation, and accelerated plaque formation, thereby increasing the risk of both peripheral and carotid artery disease [13].

The present study also demonstrated a high prevalence of hypertension and diabetes mellitus among PAD patients. Hypertension contributes to vascular endothelial injury and arterial wall remodeling, while diabetes mellitus accelerates atherosclerotic plaque formation through chronic inflammation, dyslipidemia, and vascular calcification [14]. These findings are consistent with earlier studies reporting that patients with PAD frequently have concomitant carotid artery stenosis due to shared cardiovascular risk factors [15].

Most patients in the present study had multilevel arterial disease, indicating diffuse systemic atherosclerosis. Multiple lesion involvement reflects advanced vascular pathology and increased cardiovascular risk. Previous reports have shown that the severity and extent of peripheral arterial disease are directly associated with the prevalence of asymptomatic carotid artery stenosis [16]. Patients with severe PAD are therefore more likely to harbor significant carotid artery disease even in the absence of neurological symptoms.

Multivariate analysis in the current study identified age greater than 63 years, chronic kidney disease (CKD), previous cerebrovascular disease, and ankle-brachial index (ABI) less than 0.4 as significant predictors of severe carotid artery stenosis. Increasing age is a well-recognized independent risk factor for atherosclerosis due to progressive vascular degeneration and prolonged exposure to cardiovascular risk factors [17]. The significant association between CKD and carotid artery stenosis observed in this study may be explained by chronic inflammation, endothelial dysfunction, vascular calcification, and accelerated atherosclerosis commonly seen in renal disease patients [18].

A lower ankle-brachial index was also associated with increased severity of carotid artery stenosis. ABI is an established marker of peripheral arterial disease severity and systemic atherosclerotic burden. Studies have demonstrated that patients with ABI less than 0.4 have significantly higher risks of cardiovascular and cerebrovascular events [19]. Therefore, ABI may serve as a useful indicator for identifying PAD patients who require carotid artery screening.

Carotid duplex ultrasonography proved to be an effective non-invasive imaging modality for detecting carotid artery stenosis and plaque morphology in the present study. The identification of unstable or vulnerable plaques is clinically important because such plaques are more prone to rupture and may precipitate ischemic stroke [20]. Early detection of asymptomatic carotid artery stenosis in high-risk PAD patients may facilitate timely preventive interventions including aggressive medical therapy, risk factor modification, and carotid endarterectomy in selected cases.

The present study highlights the importance of screening for asymptomatic carotid artery disease in

patients with peripheral arterial disease, particularly among elderly individuals and those with severe limb ischemia, CKD, and multilevel vascular involvement. Early diagnosis and appropriate management may reduce the risk of future cerebrovascular complications and improve long-term cardiovascular outcomes.

CONCLUSION

The present study demonstrated a significant prevalence of asymptomatic carotid artery stenosis among patients with peripheral arterial disease, supporting the concept of systemic atherosclerotic involvement of multiple vascular beds. Advanced age, chronic kidney disease, previous cerebrovascular disease, and severe peripheral arterial disease with low ankle-brachial index were significantly associated with severe carotid artery stenosis. Carotid duplex ultrasonography proved to be an effective non-invasive screening tool for early detection of carotid artery disease in high-risk PAD patients. Early identification and appropriate management of asymptomatic carotid artery stenosis may help reduce the risk of ischemic stroke and other cerebrovascular complications.

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