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Original Research Article

Role of doppler ultrasound in assessing the severity of peripheral arterial diseases of the lower limb in a tertiary care hospital: a cross-sectional study

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ABSTRACT

Background: Peripheral arterial disease (PAD) is a chronic vascular disorder characterized by reduced blood flow to the lower limbs, often leading to claudication, rest pain or critical limb ischemia. Accurate assessment of disease severity is crucial for treatment planning. Doppler ultrasound offers a non-invasive method for evaluating arterial stenosis and occlusion, yet its role in grading PAD severity is underutilized in many tertiary care settings.
Methods: A cross-sectional study was conducted in the Department of Radiodiagnosis, Jubilee Mission Medical College and Research Centre, Kerala, from January to June 2023. Thirty participants aged>18 years with clinically suspected lower limb ischemia were evaluated. Doppler ultrasound was performed on 240 arterial segments using a high-frequency linear transducer (10–12 MHz) to assess waveform patterns, peak systolic velocity and stenosis grading. Clinical severity was recorded using the Rutherford classification. Data were analyzed using SPSS 26.0, with chi-square tests applied to evaluate associations between Doppler grading and clinical severity; $p<0.05$ was considered significant.
Results: Participants were predominantly male (86.7%) and above 60 years of age (56.7%). Diabetes and hypertension were present in 66.7% and 56.7% of participants, respectively. The superficial femoral artery exhibited the highest proportion of moderate stenosis (60%). Doppler grading significantly correlated with Rutherford stages, with advanced stages (4–6) showing higher proportions of Grade 3 and 4 stenosis (Chi-square = 41.8, $p=0.001$).
Conclusions: Doppler ultrasound effectively correlates with clinical severity in PAD and allows non-invasive assessment of arterial stenosis, aiding risk stratification and treatment planning. Its use can improve outcomes, particularly in settings where patients present with advanced disease.

Keywords: Doppler ultrasound, Lower limb ischemia, Peripheral arterial disease

INTRODUCTION

PAD is a chronic vascular condition marked by compromised circulation in the lower limbs, presenting a wide array of symptoms.[1] PAD is diagnosed by the patient's medical history and physical examination. The selection of treatment techniques is determined by the severity of the disease, whereas imaging is essential for planning treatments. Compromise of arterial flow owing to stenosis and occlusions can lead to limb ischemia and is defined as any pathological disease obstructing blood flow in the arteries, excluding the coronary and cerebral vascular systems. These people exhibit a two to fourfold increased risk of coronary heart disease and stroke.[2] Peripheral arterial disease impacts a significant portion of the adult demographic. Fewer than 20% of individuals with peripheral artery disease have classic signs of intermittent claudication, whereas an additional one-third present with atypical exertional leg symptoms.[3] Ultrasound imaging is a useful diagnostic method that offers a noninvasive evaluation of the lower limb's artery system. Color Doppler assessment allows for the quick

localization of arterial stenoses and occlusions, duplex assessment measures blood velocity through a vessel and grayscale images detect plaque and thrombus.[4] The scope for noninvasive evaluation of peripheral arterial disease has expanded thanks to recent developments in duplex ultrasound, including improved postprocessing capability, transducer technology, image resolution, signal strength and spectral analysis capabilities.[5]

In a developing country like India, where a large proportion of patients present late with advanced disease, timely and accurate diagnosis using Doppler ultrasound can play a pivotal role in improving outcomes. Despite its diagnostic utility, the role of Doppler ultrasound in grading the severity of PAD and its correlation with clinical findings is still underutilized in many tertiary care centers. Hence, this study aims to evaluate the role of Doppler ultrasound in assessing the severity of peripheral arterial diseases of the lower limb in a tertiary care hospital setting.

METHODS

This cross-sectional study was conducted in the Department of Radiodiagnosis, Jubilee Mission Medical College and Research Centre, Thrissur, Kerala, over a period of six months from January 2023 to June 2023. The minimum required sample size was calculated based on the sensitivity of Doppler ultrasound in detecting PAD as reported by Prasad MBV et al, assuming a 95% confidence level and 20% relative allowable error, yielding a sample size of 240 arterial segments.[6] Patients aged above 18 years of either gender, clinically diagnosed or suspected to have lower limb ischemic disease and referred for Doppler ultrasonography were included in the study. Patients unwilling to participate, those with severe renal insufficiency (eGFR <30 mL/min/1.73 m²), extensive ulcerations or gangrene or previous vascular grafts were excluded. A convenience sampling technique was used and all consecutive eligible patients who provided informed consent were included until the desired sample size was achieved.

Doppler ultrasound was performed using a high-frequency linear array transducer (10–12 MHz). Colour flow-assisted B-mode imaging was employed to map the vessels and identify lesions and pulse Doppler was used to analyze spectral waveforms and measure peak systolic velocity (PSV). The insonation angle was maintained at approximately 60° to the vessel axis. A normal triphasic waveform with full colour filling indicated a patent vessel, while absence of flow and Doppler signal denoted occlusion. Non-occlusive lesions were identified by altered colour flow, vessel calibre variation and spectral broadening. Hemodynamically significant stenosis (>50%) was diagnosed when the waveform changed from triphasic to monophasic with spectral broadening and a PSV ratio greater than 2, calculated relative to a proximal reference segment showing normal flow at least 4 cm away. The clinical severity of PAD in participants was assessed using the Rutherford classification, which categorizes patients based on symptom severity ranging from asymptomatic or mild claudication to rest pain, ulceration or gangrene. This classification was recorded for each participant to allow correlation with Doppler findings.

Data were entered into Microsoft Excel and analyzed using SPSS version 26.0. Descriptive statistics were used to summarize demographic and clinical variables. The severity of disease was categorized based on Doppler findings and associations between Doppler-detected disease severity and clinical parameters were analyzed using chi-square tests. A p value of <0.05 was considered statistically significant.

RESULTS

The study included 30 participants with a total of 240 arterial segments evaluated. The majority of participants were above 60 years of age (56.7%), followed by 33.3% in the 45–60 years age group and 10.0% under 45 years. Males predominated the study population, accounting for 86.7%, while females comprised 13.3%. Regarding comorbidities, 66.7% of participants had diabetes and 56.7% had hypertension. The left leg was slightly more frequently examined (53.3%) than the right leg (46.7%) (Table 1).

In the external iliac artery, most segments exhibited mild stenosis (Grade 1, 60.0%), with fewer segments showing moderate (26.7%), severe (10.0%) or occlusive (3.3%) disease. The common femoral artery demonstrated a relatively even distribution across Grades 1 to 4, with the highest proportion in Grade 2 (43.3%).

The superficial femoral artery had predominantly Grade 2 stenosis (60.0%), while the deep femoral artery largely showed Grade 1 (80.0%) and Grade 2 (20.0%), with no severe or occlusive lesions. In the popliteal artery, mild and moderate stenoses were observed in 36.7% each, with fewer severe (16.7%) and occlusive (10.0%) cases. The anterior tibial artery mostly demonstrated Grade 1 (56.7%) and Grade 2 (36.7%) lesions, with minimal Grade 3 stenosis. The posterior tibial artery had the majority in Grade 2 (46.7%), while the dorsalis pedis artery showed Grade 1 stenosis in 63.3% of segments (Table 2).

Participants in stage 0–1 (asymptomatic or mild claudication) predominantly had Grade 1 stenosis (86.7%), indicating that mild clinical symptoms were generally associated with minimal arterial narrowing. In stage 2–3 (moderate–severe claudication), stenosis grades were more evenly distributed: 42.1% of segments were grade 1, 36.8% grade 2, 15.8% grade 3 and 5.3% Grade 4, reflecting the progression of arterial disease with worsening symptoms. Participants in stage 4–6 (rest pain, ulcer or gangrene) exhibited higher grades of stenosis, with grade 3 (25.0%) and Grade 4 (8.4%) representing

more severe arterial compromise. The association between doppler grading and clinical severity was statistically significant (Chi-square=41.8, p=0.001), highlighting that doppler ultrasound accurately reflects the clinical progression of peripheral arterial disease (Table 3).

Table 1: Demographic and clinical characteristics of study participants.

Socio-demographic Profile	Category	Number	(%)
Age (in years)	<45	3	10
	45–60	10	33.3
	>60	17	56.7
Gender	Male	26	86.7
	Female	4	13.3
Diabetes	Present	20	66.7
	Absent	10	33.3
Hypertension	Present	17	56.7
	Absent	13	43.3
Leg examined	Left Leg	16	53.3
	Right Leg	14	46.7

Table 2: Degree of stenosis in various arteries by ultrasound among study participants.

Artery	Grade 1, N (%)	Grade 2, N (%)	Grade 3, N (%)	Grade 4, N (%)
External iliac artery	18 (60.0)	8 (26.7)	3 (10.0)	1 (3.3)
Common femoral artery	9 (30.0)	13 (43.3)	6 (20.0)	2 (6.7)
Superficial femoral artery	1 (3.3)	18 (60.0)	10 (33.3)	1 (3.3)
Deep femoral artery	24 (80.0)	6 (20.0)	0 (0.0)	0 (0.0)
Popliteal artery	11 (36.7)	11 (36.7)	5 (16.7)	3 (10.0)
Anterior tibial artery	17 (56.7)	11 (36.7)	2 (6.7)	0 (0.0)
Posterior tibial artery	12 (40.0)	14 (46.7)	4 (13.3)	0 (0.0)
Dorsalis pedis artery	19 (63.3)	9 (30.0)	2 (6.7)	0 (0.0)

Table 3: Association between clinical severity (Rutherford classification) and doppler grading of stenosis among study participants (n=240 segments).

Clinical category (Rutherford classification)	Grade 1 (Mild) N (%)	Grade 2 (Moderate) N (%)	Grade 3 (Severe) N (%)	Grade 4 (Occlusion) N (%)	Chi-Square	P value
Stage 0–1: asymptomatic / mild claudication	78 (86.7)	12 (13.3)	0 (0.0)	0 (0.0)		
Stage 2–3: moderate–severe claudication	48 (42.1)	42 (36.8)	18 (15.8)	6 (5.3)	41.8	0.001
Stage 4–6: rest pain / ulcer / gangrene	12 (33.3)	12 (33.3)	9 (25.0)	3 (8.4)		
Total (n=240)	138 (57.5)	66 (27.5)	27 (11.3)	9 (3.7)		

DISCUSSION

The present study evaluated 240 arterial segments across 30 participants and found a significant correlation between Doppler ultrasound grading and clinical severity of peripheral arterial disease as assessed by the Rutherford classification (p=0.001). The predominance of male patients (86.7%) and elderly individuals above 60 years (56.7%) aligns with established epidemiological patterns of PAD. The high prevalence of diabetes (66.7%) and hypertension (56.7%) among participants corresponds with known risk factors for atherosclerotic vascular disease. A study by Collins et al reported similar demographic patterns, with diabetes and hypertension being the most common comorbidities in PAD patients and demonstrated that duplex ultrasonography had 87% sensitivity and 94% specificity for detecting

hemodynamically significant stenosis.[7] The superficial femoral artery showed the highest proportion of moderate stenosis (60.0% Grade 2), which is consistent with literature indicating this vessel as the most commonly affected site in lower limb PAD.[8] The distribution of stenosis severity across different arterial segments revealed distinct patterns, with the deep femoral artery demonstrating predominantly mild disease (80.0% Grade 1) and no severe or occlusive lesions, possibly reflecting its role as a collateral pathway that may be relatively spared in atherosclerotic disease. The external iliac and dorsalis pedis arteries similarly showed predominance of mild stenosis, while the common femoral and popliteal arteries exhibited more heterogeneous disease distribution.

These findings are supported by a study by Eiberg et al which reported that color duplex scanning had 80% sensitivity for detecting >50% stenosis in the aortoiliac segment and 83% sensitivity in the femoropopliteal segment, with overall accuracy of 85% when compared with angiography.[9] The correlation between higher Doppler grades and advanced Rutherford stages (4-6) demonstrates the clinical utility of Doppler ultrasound in risk stratification, as participants with rest pain, ulceration or gangrene showed substantially higher proportions of Grade 3 and Grade 4 stenosis compared to those with mild symptoms. The significant association between doppler-detected stenosis severity and clinical stage validates the use of duplex ultrasonography as a reliable noninvasive modality for PAD assessment in resource-limited settings. Mohler et al, emphasized that duplex ultrasound provides accurate anatomic localization and hemodynamic assessment of lower extremity arterial disease, making it particularly valuable for treatment planning and surveillance.[10]

CONCLUSION

The study demonstrated a statistically significant correlation between doppler ultrasound grading and clinical severity of peripheral arterial disease (p=0.001). The superficial femoral artery showed the highest proportion of moderate stenosis (60%), while the deep femoral artery remained relatively spared. Patients with critical limb ischemia exhibited substantially higher grades of stenosis compared to those with mild claudication. Doppler ultrasound proved effective in noninvasively assessing PAD severity and guiding clinical management decisions in tertiary care settings.

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REFERENCES

1. Martinelli O, Alunno A, Drudi FM, Malaj A, Irace L. Duplex ultrasound versus CT angiography for the treatment planning of lower-limb arterial disease. J Ultrasound. 2021;24(4):471-9.
2. Kandasamy G, Maithrayee A, Kailasanathan N. Lower limb arteries assessed with Doppler angiography. a prospective comparative study with multi detector CT angiography. Inter J Latest Res Sci Technol. 2015;4(6):70–83.
3. Kasapis C, Gurm HS. Current approach to the diagnosis and treatment of femoral popliteal arterial disease. A Systematic Review. Curr Cardiol Rev. 2009;5(4):296–311.
4. Favaretto E, Pili C, Amato A, Conti E, Losinno F, Rossi C, et al. Analysis of agreement between Duplex ultrasound scanning and arteriography in patients with lower limb artery disease. J Cardiovasc Med (Hagerstown). 2007;8:337–41.
5. Islam SN, Deka N, Hussain Z. Role of Doppler Ultrasound in Assessing the Severity of Peripheral Arterial Diseases of the Lower Limb. J Med Ultrasound. 2021;13;29(4):277-80.
6. Prasad MBV, Boppana S, Reddy M, Juvvadi N, R, R. Computed tomography angiography evaluation of peripheral arterial disease and correlation with colour doppler, Asian J Med Radio. Res. 2020;8(2):73-9.
7. Collins R, Burch J, Cranny G, Aguiar-Ibáñez R, Craig D, Wright K, et al. Duplex ultrasonography, magnetic resonance angiography and computed tomography angiography for diagnosis and assessment of symptomatic, lower limb peripheral arterial disease: systematic review. BMJ. 2007;334(7606):1257.
8. Norgren L, Hiatt WR, Dormandy JA, Nehler MR, Harris KA, Fowkes FG. Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II). J Vasc Surg. 2007;45(4):5-67.
9. Eiberg JP, Grønvall Rasmussen JB, Hansen MA, Schroeder TV. Duplex ultrasound scanning of peripheral arterial disease of the lower limb. Eur J Vasc Endovasc Surg. 2010;40(4):507-12.
10. Mohler ER, Treat-Jacobson D, Reilly MP, Cunningham KE, Miani M, Criqui MH, et al. Utility and barriers to performance of the ankle-brachial index in primary care practice. Vasc Med. 2004;9(4):253-60.

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