

Original Research Article

CT ANGIOGRAPHY VERSUS DOPPLER ULTRASOUND IN PERIPHERAL ARTERIAL DISEASE: A COMPARATIVE STUDY

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ABSTRACT

Background: Peripheral arterial disease is an important manifestation of systemic atherosclerosis, and accurate assessment of arterial stenosis and occlusion is essential for appropriate management. Doppler ultrasonography is widely used as a non-invasive first-line investigation, while CT angiography provides detailed anatomical visualization. The aim is to compare the diagnostic performance of CT angiography and Doppler ultrasonography in patients with peripheral arterial disease.

Materials and Methods: A prospective comparative observational study was conducted in the Department of Radiodiagnosis at Shri Sathya Sai Medical College and Research Institute over one year. A total of 180 patients underwent both Doppler ultrasound and CT angiography.

Results: Most patients were aged 61–70 years (31.1%). Intermittent claudication was the commonest presentation (62.2%). CTA demonstrated higher sensitivity (96.2%), specificity (97.1%) and diagnostic accuracy (96.7%) compared with Doppler ultrasound (86.4%, 91.7%, and 89.1%, respectively; $p < 0.001$).

Conclusion: CTA showed superior diagnostic performance, while Doppler ultrasound remained useful for initial evaluation.

Keywords: Peripheral arterial disease; CT angiography; Doppler ultrasonography; Arterial stenosis; Vascular imaging.

INTRODUCTION

Peripheral arterial disease (PAD) is a common manifestation of systemic atherosclerosis characterized by narrowing or occlusion of the peripheral arteries, most frequently affecting the lower extremities. It may present with intermittent claudication, rest pain, non-healing ulcers, or critical limb-threatening ischemia, and timely identification of the location and severity of arterial lesions is essential for appropriate treatment planning. With the increasing burden of diabetes, hypertension, smoking, and an ageing population, accurate and non-invasive assessment of peripheral arterial circulation has become an important component of contemporary vascular care.^[1,2]

Doppler ultrasonography, particularly colour duplex ultrasound, is widely used as an initial imaging

modality because it is non-invasive, radiation-free, relatively inexpensive, and capable of providing both anatomical and haemodynamic information through assessment of flow velocity and spectral waveforms. Recent evidence indicates good diagnostic performance of duplex ultrasound, although its accuracy may vary according to the arterial segment examined, operator expertise, vascular calcification, obesity, and the presence of extensive disease.^[2,3] A recent systematic review and meta-analysis reported an overall sensitivity of approximately 86% and specificity of 95% for duplex ultrasound in symptomatic PAD, with relatively lower sensitivity in below-knee arterial segments.^[4]

Computed tomography angiography (CTA), on the other hand, provides rapid, high-resolution visualization of the arterial tree and allows assessment of the distribution, severity, and extent of

stenotic and occlusive lesions. It is particularly useful when detailed anatomical mapping is required for revascularization planning. Comparative studies have demonstrated substantial agreement between CTA, duplex ultrasound, and digital subtraction angiography, although each modality has specific technical advantages and limitations.^[1,5] Current guidelines recognize duplex ultrasound, CTA, magnetic resonance angiography, and catheter angiography as useful imaging options when anatomical assessment is required, with the choice depending on clinical circumstances and the need for revascularization.^[6]

The present study aims to compare the diagnostic performance of CT angiography and Doppler ultrasonography in patients with peripheral arterial disease. It seeks to assess their ability to identify and characterize arterial stenosis, occlusion, and the extent of vascular involvement. The study also aims to determine the level of agreement between the two imaging modalities and evaluate their relative usefulness in the diagnosis and management planning of peripheral arterial disease.

MATERIALS AND METHODS

Study design: This will be a prospective comparative observational study.

Study population: The study will include patients clinically suspected of having peripheral arterial disease who are referred for vascular imaging.

Sample size: A total of 180 patients will be included in the study.

Study duration: The study will be conducted over a period of 1 year.

Study setting/location: The study will be carried out in the Department of Radiodiagnosis, Shri Sathya Sai Medical College and Research Institute, Nellikuppam, Kancheepuram District.

Inclusion criteria

Patients with clinical suspicion or diagnosis of peripheral arterial disease who undergo both Doppler ultrasonography and CT angiography will be included.

Exclusion criteria

Patients who do not undergo both imaging investigations, those with contraindications to CT angiography or iodinated contrast, and patients with incomplete clinical or imaging data will be excluded.

Statistical Analysis: Data collected from the study will be entered into Microsoft Excel and analysed using appropriate statistical software. Categorical variables will be expressed as frequency and percentage, while continuous variables will be

presented as mean $\pm$ standard deviation where applicable. The diagnostic findings of Doppler ultrasonography and CT angiography will be compared using the Chi-square test or Fisher's exact test for categorical variables, as appropriate. Diagnostic performance will be assessed in terms of sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy. The level of agreement between the two imaging modalities will also be assessed where appropriate. A p-value <0.05 will be considered statistically significant, with $p<0.001$ considered highly significant.

RESULTS

[Table 1] The study included 180 patients. The largest proportion belonged to the 61–70-year age group (56, 31.1%), followed by 51–60 years (48, 26.7%) and >70 years (36, 20.0%). Patients aged 41–50 years accounted for 28 (15.6%), while 12 (6.7%) were below 40 years. The age distribution was statistically significant ($p=0.032$).

[Table 2] The commonest clinical presentation was intermittent claudication, seen in 112 patients (62.2%, $p<0.001$), followed by non-healing ulcer in 54 (30.0%, $p=0.006$) and rest pain in 48 (26.7%, $p=0.018$). Gangrene was present in 24 (13.3%, $p=0.041$). Among risk factors, hypertension was most frequent (116, 64.4%, $p<0.001$), followed by diabetes mellitus (104, 57.8%, $p<0.001$), smoking (92, 51.1%, $p=0.003$) and dyslipidaemia (76, 42.2%, $p=0.021$).

[Table 3] CT angiography detected more arterial lesions than Doppler ultrasound. The most frequently involved segment was the superficial femoral artery, detected in 86 (47.8%) by Doppler and 94 (52.2%) by CT angiography ($p=0.041$). Multilevel disease was identified in 72 (40.0%) by Doppler compared with 86 (47.8%) by CTA ($p=0.028$). Significant differences were also observed for the anterior tibial artery (26.7% vs 34.4%, $p=0.018$), posterior tibial artery (30.0% vs 37.8%, $p=0.011$) and peroneal artery (21.1% vs 28.9%, $p=0.015$).

[Table 4] Doppler ultrasound demonstrated a sensitivity of 86.4%, specificity of 91.7%, positive predictive value of 92.8%, negative predictive value of 84.0%, and diagnostic accuracy of 89.1%. CT angiography showed higher values, with 96.2% sensitivity, 97.1% specificity, 97.6% positive predictive value, 95.4% negative predictive value, and 96.7% diagnostic accuracy. The difference in overall diagnostic accuracy was statistically significant ($p<0.001$), indicating superior diagnostic performance of CTA.

Table 1: Age-wise Distribution of Study Participants

Age group (years)	Number of patients (n)	Percentage (%)	p-value
<40	12	6.7	0.032
41–50	28	15.6	
51–60	48	26.7	
61–70	56	31.1	
>70	36	20	
Total	180	100	

Table 2: Clinical Presentation and Major Risk Factors

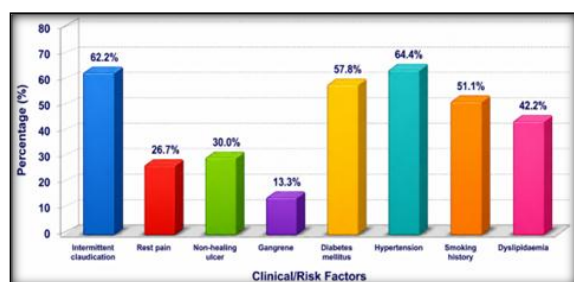
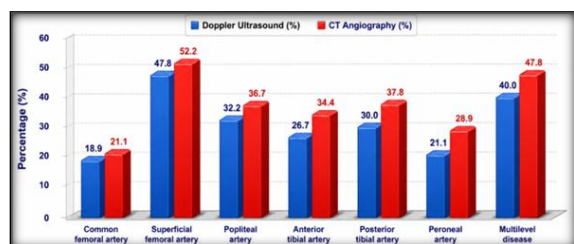
Clinical/risk factor	Number of patients (n=180)	Percentage (%)	p-value
Intermittent claudication	112	62.2	<0.001
Rest pain	48	26.7	0.018
Non-healing ulcer	54	30	0.006
Gangrene	24	13.3	0.041
Diabetes mellitus	104	57.8	<0.001
Hypertension	116	64.4	<0.001
Smoking history	92	51.1	0.003
Dyslipidaemia	76	42.2	0.021

Table 3: Comparison of Arterial Lesions Detected by Doppler Ultrasound and CT Angiography

Arterial segment	Doppler ultrasound n (%)	CT angiography n (%)	p-value
Common femoral artery	34 (18.9)	38 (21.1)	0.512
Superficial femoral artery	86 (47.8)	94 (52.2)	0.041
Popliteal artery	58 (32.2)	66 (36.7)	0.084
Anterior tibial artery	48 (26.7)	62 (34.4)	0.018
Posterior tibial artery	54 (30.0)	68 (37.8)	0.011
Peroneal artery	38 (21.1)	52 (28.9)	0.015
Multilevel disease	72 (40.0)	86 (47.8)	0.028

Table 4: Diagnostic Performance of Doppler Ultrasound Compared with CT Angiography

Diagnostic parameter	Doppler ultrasound (%)	CT angiography (%)	p-value
Sensitivity	86.4	96.2	0.001
Specificity	91.7	97.1	0.012
Positive predictive value	92.8	97.6	0.018
Negative predictive value	84	95.4	0.003
Diagnostic accuracy	89.1	96.7	<0.001

**Figure 1: Clinical and Risk Factors Among Patients with Peripheral Arterial Disease****Figure 2: Comparison of Arterial Segment Involvement Detected by Doppler Ultrasound and CT Angiography**

DISCUSSION

In the present study, the majority of patients were in the 61–70-year age group (31.1%), followed by 51–60 years (26.7%), with a significant age distribution ($p=0.032$). This predominance of older patients is consistent with the established relationship between increasing age and atherosclerotic peripheral arterial disease. Contemporary literature similarly identifies advancing age as an important determinant of PAD burden and severity.^[7,8]

Intermittent claudication (62.2%) was the commonest presenting symptom, while hypertension

(64.4%), diabetes mellitus (57.8%), smoking (51.1%), and dyslipidaemia (42.2%) were the major associated risk factors. These findings are in agreement with recent evidence showing that traditional cardiovascular risk factors, particularly diabetes, hypertension, and tobacco exposure, contribute substantially to lower-extremity arterial disease.^[9,10]

The present study demonstrated greater detection of arterial abnormalities by CTA, particularly in the superficial femoral artery (52.2%) and in multilevel disease (47.8%). CTA also detected more anterior tibial, posterior tibial, and peroneal lesions than Doppler ultrasound. Martinelli et al. reported good agreement between DUS and CTA but noted that CTA could provide additional anatomical information useful for revascularization planning.^[11] Similarly, another comparative study found DUS to be somewhat less accurate than CTA in selected arterial territories when assessed against digital subtraction angiography.^[12]

Doppler ultrasound in our study showed 86.4% sensitivity, 91.7% specificity, and 89.1% diagnostic accuracy, whereas CTA demonstrated 96.2% sensitivity, 97.1% specificity, and 96.7% accuracy, with the difference in accuracy being significant ($p<0.001$). These findings are broadly consistent with the 2025 systematic review by Dias et al., which reported good overall DUS sensitivity and specificity but comparatively poorer performance below the knee.^[13] Recent work on CTA has also emphasized its ability to provide detailed visualization of stenosis, occlusion, calcification, and the overall arterial pathway.^[14,15] Thus, the present findings support Doppler ultrasound as a useful first-line, non-invasive examination, while CTA provides more

comprehensive anatomical mapping when detailed assessment and revascularization planning are required.

CONCLUSION

The present study demonstrates that peripheral arterial disease was predominantly observed among older patients, with hypertension, diabetes, smoking, and dyslipidaemia being important associated risk factors. Intermittent claudication was the most common clinical presentation. CT angiography detected a greater number of arterial lesions, particularly in distal and multilevel disease, compared with Doppler ultrasonography. CTA also demonstrated superior sensitivity, specificity, predictive values, and overall diagnostic accuracy. However, Doppler ultrasound remains a valuable, non-invasive, radiation-free first-line investigation. Overall, the findings suggest that Doppler ultrasound is useful for initial assessment, while CT angiography provides more comprehensive anatomical evaluation and is particularly valuable for treatment and revascularization planning.

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