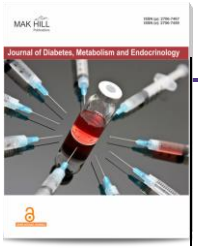
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Research Article

Peripheral Artery Disease in Patients Presenting With Acute Coronary Syndrome: Prevalence, Ankle–Brachial Index, and Coronary Atherosclerotic Burden in a Northern Indian Cohort.

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Abstract: ***Background:*** Peripheral artery disease (PAD) and acute coronary syndrome (ACS) are manifestations of systemic atherosclerosis. Concomitant PAD may identify a polyvascular phenotype and greater atherosclerotic burden. The ankle–brachial index (ABI) is a non-invasive physiological test for PAD. Data on ABI-assessed PAD and its coronary anatomical correlates in northern Indian patients with ACS are limited. ***Methods:*** We conducted an observational cross-sectional study of 288 consecutive patients presenting with ACS. ABI was measured during hospitalization using an automated plethysmographic device. Lower-limb computed tomography angiography (CTA) was performed according to the study protocol. Coronary angiography, left ventricular ejection fraction (LVEF) and SYNTAX score were recorded where available. ***Results:*** Among 288 patients, 238 (82.6%) were men and mean age was 57.4±11.36 years. STEMI accounted for 197 (68.4%) presentations. Hypertension was present in 214 (74.3%) and smoking in 207 (71.9%). Seventeen patients had ABI ≤0.90 amongst whom CTA demonstrated significant lower-limb atherosclerotic disease in 88.2% (15) patients and 19 had borderline ABI (0.91–0.99). Coronary angiography was performed in 240 patients; single-, double- and triple-vessel disease were reported in 135 (56.3%), 69 (28.8%) and 36 (15.0%), respectively. ***Conclusion:*** ABI-defined PAD was identified in a minority of patients with ACS. Among patients with ABI ≤0.90 who underwent CTA, 88.2% had significant lower-limb atherosclerotic disease. The findings highlight the potential value of assessing peripheral vascular disease in patients presenting with ACS.

Keywords: acute coronary syndrome; peripheral artery disease; ankle–brachial index; polyvascular disease; computed tomography angiography; coronary artery disease; SYNTAX score; India.

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INTRODUCTION

Peripheral artery disease is a manifestation of systemic atherosclerosis and is associated with cardiovascular and limb morbidity. PAD may be asymptomatic or clinically atypical, making objective physiological assessment relevant in patients with established atherosclerotic disease.[1–4] The ankle–brachial index provides a non-invasive assessment of lower-extremity arterial perfusion. The 2024 ACC/AHA PAD guideline classifies ABI as abnormal (≤0.90), borderline (0.91–0.99), normal (1.00–1.40), or noncompressible (>1.40).[1] The 2024 ESC guideline also incorporates lower-extremity PAD into a broader framework of peripheral arterial, aortic and polyvascular disease.[2]

ACS is an acute clinical manifestation of coronary atherosclerosis. Contemporary ACS guidance emphasizes risk assessment, invasive evaluation when indicated, and secondary prevention across STEMI and non-ST-elevation ACS.[5] Registry data indicate that concomitant PAD in ACS is associated with greater systemic atherosclerotic burden and adverse ischemic risk.[6–9] The prevalence and anatomical correlates of objectively detected PAD may vary with age, risk factors, ascertainment methods and population characteristics.

Indian data on PAD in patients presenting with ACS remain limited. The CREATE registry described important differences in ACS presentation and management across India, while community-based Indian data have demonstrated PAD in older populations.[10,11] The relationship between ABI-defined PAD and coronary anatomical disease in a northern Indian ACS population has not been well characterized.

We evaluated ABI-defined PAD among patients presenting with ACS, examined lower-limb CTA findings, and explored the association between PAD and coronary angiographic disease burden.

MATERIALS AND METHODS

Study design and population

This observational cross-sectional study was conducted over a two-year period at a tertiary-care cardiovascular centre in northern India. Consecutive patients presenting with ACS, including STEMI, NSTEMI and unstable angina/NST-ACS, were considered. Institutional ethical clearance was obtained, and informed consent was obtained from patients or relatives for use of clinical data for research purposes. The reported sample-size calculation used a 99% confidence level and 10% margin of error, yielding a minimum sample size of 166; 288 patients were included.

The study excluded patients with deranged kidney function, contrast allergy, refusal of consent or coronary angiography, known PAD, cardiogenic shock and other major structural complications.

Clinical and biochemical assessment

Demographic characteristics and cardiovascular risk factors were recorded, including age, sex, smoking, diabetes mellitus, hypertension, dyslipidaemia and family history of coronary artery disease. Diabetes was defined using fasting glucose >126 mg/dL, HbA1c >6.5%, or random glucose >200 mg/dL with symptoms. Hypertension was defined as systolic blood pressure >130 mmHg and/or diastolic blood pressure >90 mmHg or current treatment.

Lipid testing was performed on admission or within 48 hours and before high-intensity statin therapy where possible. Lipid results from 204 patients were included in the final lipid analysis; 54 patients had received high-dose statins before referral and 30 presented more than 48 hours after myocardial infarction. Dyslipidaemia was defined in the source study using total cholesterol >200 mg/dL, LDL cholesterol >130 mg/dL, low HDL cholesterol and triglycerides >150 mg/dL.

ABI assessment

ABI was assessed during hospitalization using the MESI ABPI MD® automated device (MESI, Slovenia), incorporating simultaneous cuff inflation and plethysmographic assessment. The device used the PADsense™ algorithm. ABI categories were classified according to contemporary guideline thresholds: abnormal ≤0.90, borderline 0.91–0.99, normal 1.00–1.40 and noncompressible >1.40.[1]

Lower-limb CTA

Lower-limb CTA was performed according to the study protocol in patients with ABI <1.00, approximately three weeks after the index admission. Significant obstructive lower-extremity atherosclerotic disease was identified radiologically. CTA demonstrated significant disease in 15 of 17 patients with ABI ≤0.90 (88.2%).

Echocardiography and coronary angiography

Baseline two-dimensional echocardiography was performed. Coronary angiography was performed when clinically appropriate and when no contraindication was present, followed by revascularization according to contemporary clinical recommendations. Coronary anatomy was categorized as single-, double- or triple-vessel disease, and SYNTAX score was recorded.

Statistical analysis

Data were summarized using descriptive statistics. Continuous variables were expressed as mean±standard deviation, and categorical variables as counts and percentages. Comparisons were performed using independent-samples t-tests for continuous variables and appropriate tests for categorical variables, with p≤0.05 considered statistically significant. The reported analysis was based on available study data.

RESULTS

Study population and baseline characteristics

A total of 288 patients were included. As shown in Table 1, mean age was 57.4±11.36 years and 238 (82.6%) patients were men. STEMI accounted for 197 (68.4%) presentations and NST-ACS for 91 (31.6%). Hypertension was present in 214 (74.3%), smoking in 207 (71.9%), and diabetes mellitus in 101 (35.1%).

Lipid testing was available for 204 patients; 194 (95.1%) fulfilled the study's dyslipidaemia definition, driven predominantly by low HDL cholesterol (Table 2).

Table 1. Baseline clinical characteristics of the study cohort.

Variable	Overall, n=288
Age, years	57.4±11.36
Male sex	238 (82.6%)
Female sex	50 (17.4%)
BMI, kg/m^2	24.53±2.75
Smoking	207 (71.9%)
Diabetes mellitus	101 (35.1%)
Hypertension	214 (74.3%)
Family history of CAD	26 (9.0%)
STEMI	197 (68.4%)
NST-ACS	91 (31.6%)

Lipid variable	n (%)
Dyslipidaemia, overall	194/204 (95.1%)
Total cholesterol >200 mg/dL	30/204 (14.7%)
LDL cholesterol >130 mg/dL	26/204 (12.7%)
Low HDL cholesterol*	176/204 (86.3%)
Triglycerides >150 mg/dL	70/204 (34.3%)

*Low HDL was defined in the source study as <40 mg/dL in men and <50 mg/dL in women. Table 2. Lipid profile of patients with available measurements.

ABI distribution and lower-limb CTA findings

ABI assessment was performed during hospitalization. Seventeen patients had ABI ≤0.90 and 19 had borderline ABI (0.91–0.99). The CTA-positive proportion among patients with ABI ≤0.90 was 15/17 (88.2%). Figure 2 illustrates the ABI categories.

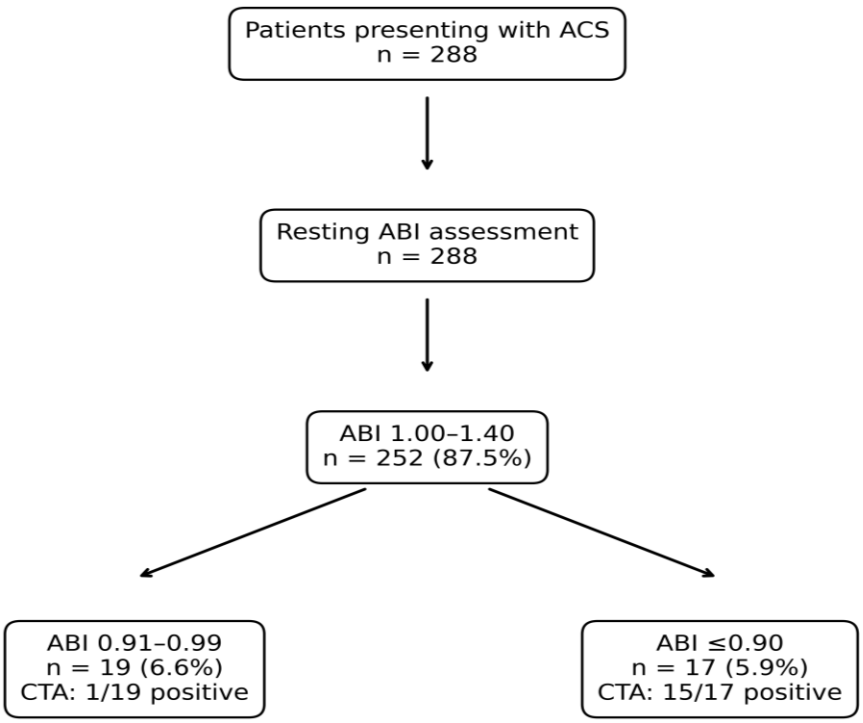


Figure 1. Study flow and ABI/CTA pathway in the 288-patient ACS cohort.

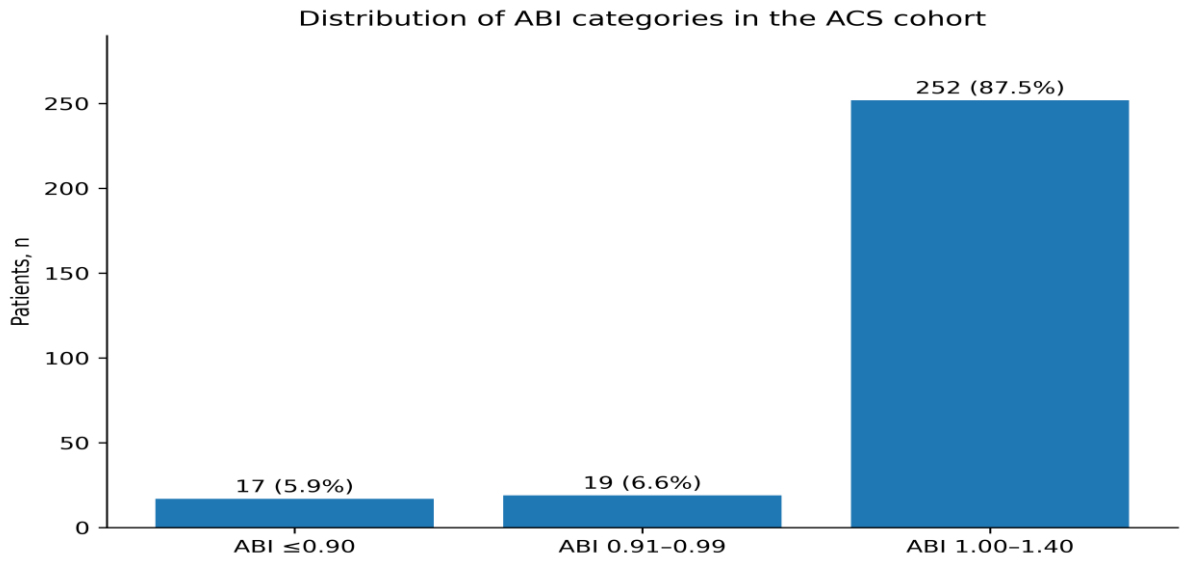


Figure 2. Distribution of ABI categories in the 288-patient ACS cohort.

Among the 17 patients with ABI ≤0.90, CTA demonstrated significant lower-limb atherosclerotic disease in 15 (88.2%) (Figure 3; Table 3). CTA was performed selectively according to ABI, so whole-cohort diagnostic sensitivity and specificity cannot be calculated from these data.

Table 3. ABI categories and lower-limb CTA findings. CTA positivity was 15/17 (88.2%) among patients with ABI ≤0.90. Separate CTA positivity for the borderline ABI category was not reported.

ABI category	n (%)	CTA-positive	CTA-positive %
ABI ≤0.90	17 (5.9%)	15/17	88.2%
Borderline ABI (0.91–0.99)	19 (6.6%)	Not reported separately	—
Normal ABI (1.00–1.40)	252 (87.5%)	Not performed	—

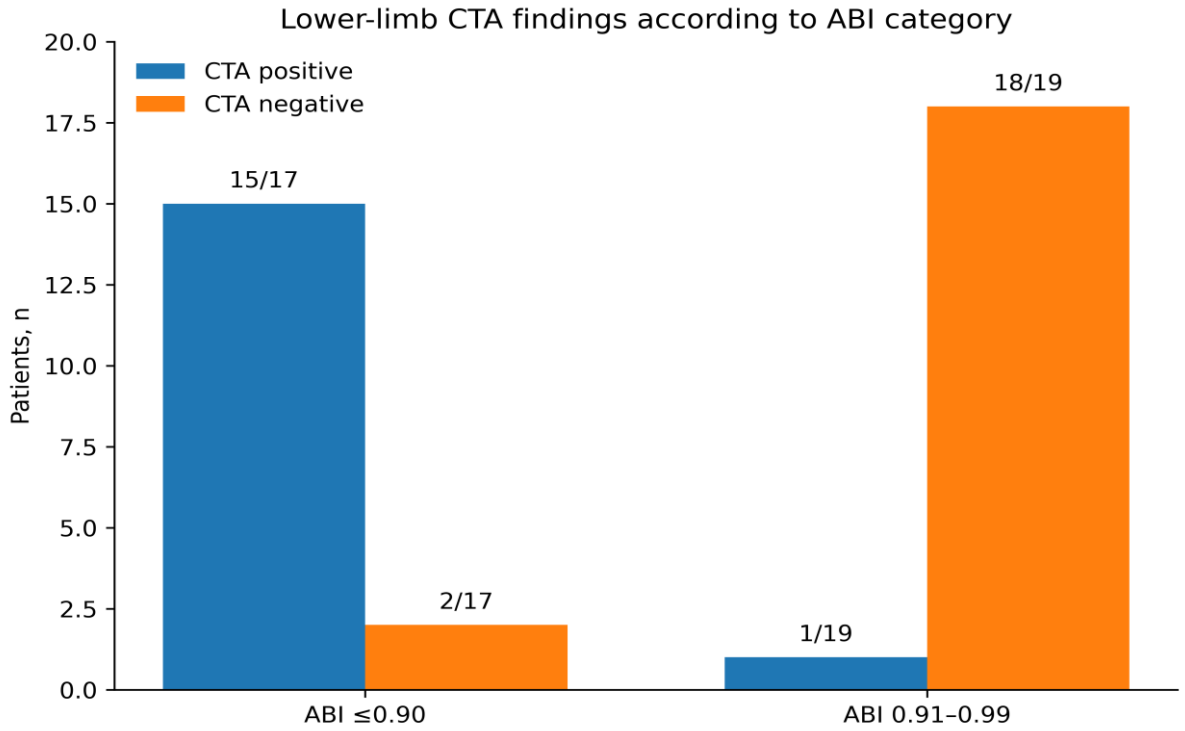


Figure 3. CTA findings among patients with ABI ≤0.90.

Coronary angiographic and echocardiographic findings

Coronary angiography was performed in 240 patients. Single-vessel, double-vessel and triple-vessel disease were reported in 135 (56.3%), 69 (28.8%) and 36 (15.0%), respectively (Table 4). Mean LVEF was 52.5±11.28%. Mean SYNTAX score was reported as 7.87±7.80.

Table 4. Coronary angiographic and echocardiographic characteristics.

Parameter	ACS cohort	STEMI	NST-ACS
LVEF, %	52.5±11.28 (n=288)	50.2±10.03 (n=197)	57.4±12.24 (n=91)
SYNTAX score	7.87±7.80 (n=240)	7.09±6.49 (n=167)	9.62±9.97 (n=73)
CAG performed	240	166	74
SVD	135 (56.3%)	99	36
DVD	69 (28.8%)	48	21
TVD	36 (15.0%)	19	17

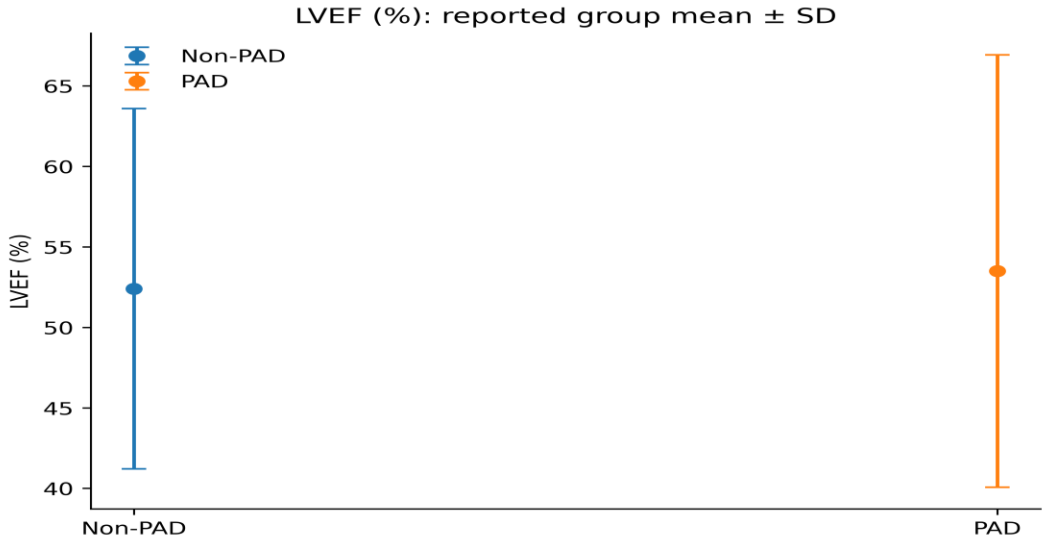


Figure 4. Reported LVEF according to PAD status.

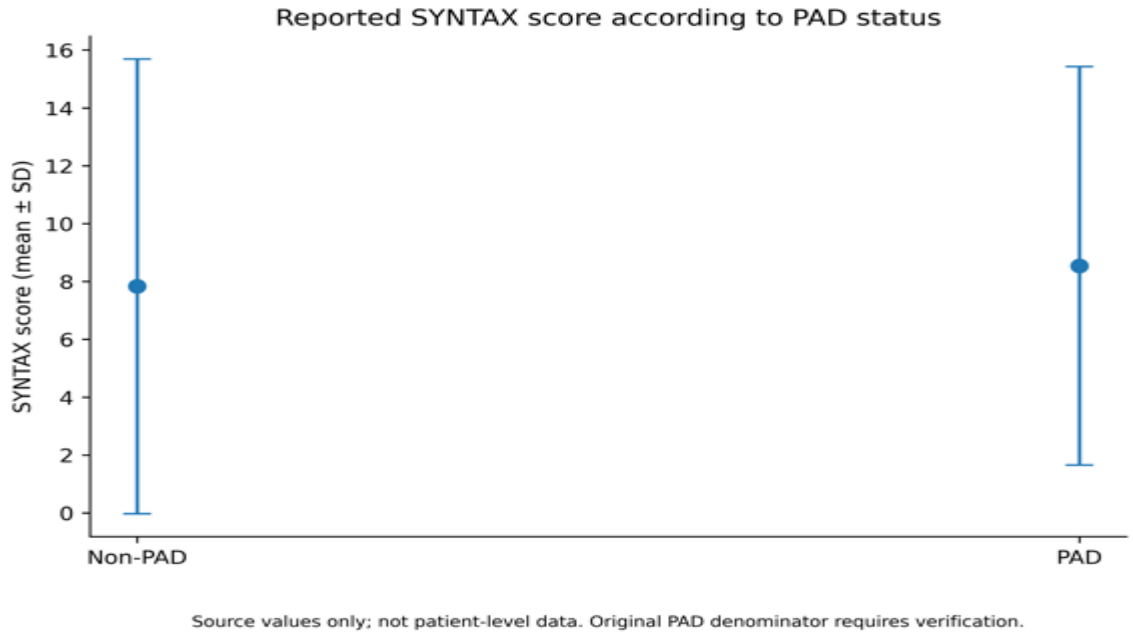


Figure 5. Reported SYNTAX score according to PAD status.

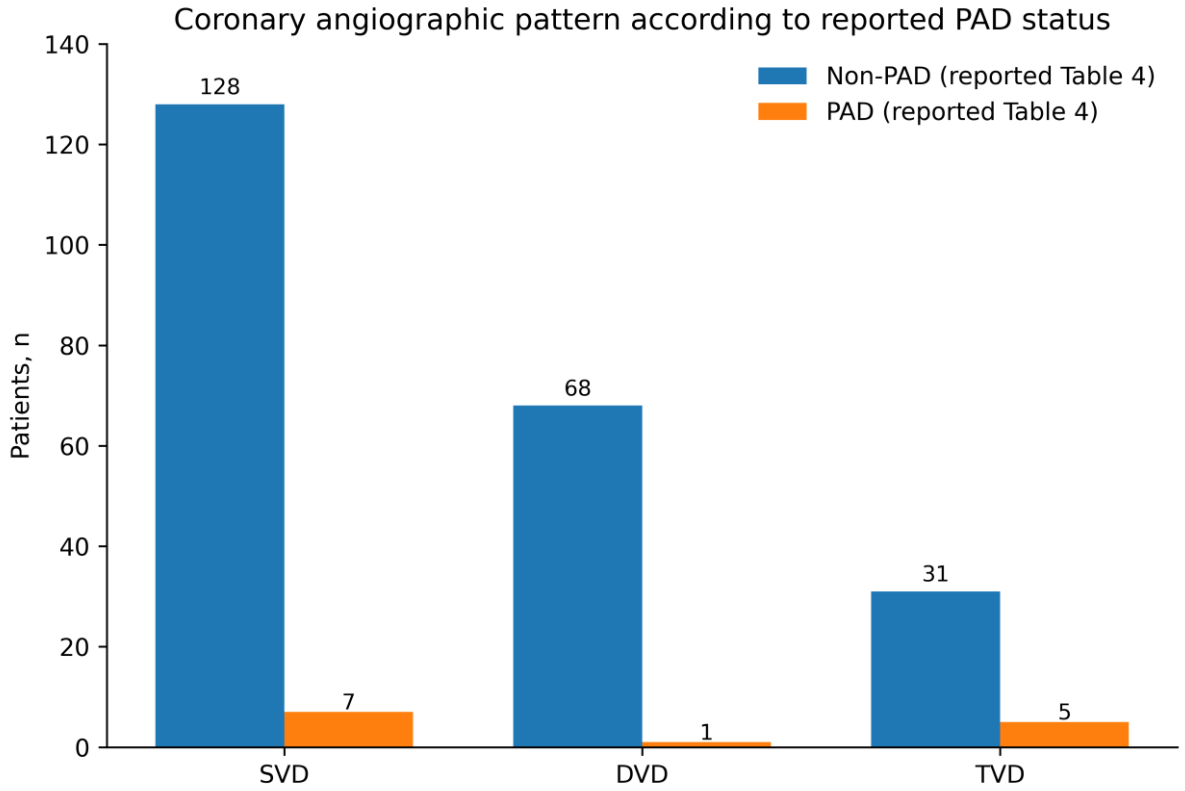


Figure 6. Coronary angiographic pattern according to PAD status.

Clinical characteristics according to PAD status

Note: PAD group total n=17; coronary angiographic data were available for 13 patients in the PAD group and 227 patients in the non-PAD group. *Dyslipidaemia percentages are based on available lipid data. †Coronary angiographic percentages are based on available angiography data. Verify all row-level denominators against the source dataset before submission.

Table 5. Clinical, biochemical and angiographic comparison according to PAD status.

Variable	Non-PAD (n=271)	PAD (n=17)	p
Age, years	57.5±11.35	54.8±11.49	0.391
Male sex	229 (84.2%)	9 (56.3%)	0.192
BMI, kg/m^2	24.54±2.74	24.23±3.06	0.688
Smoking	198 (72.8%)	9 (56.3%)	0.828
Hypertension	205 (75.4%)	9 (56.3%)	0.668
Diabetes	94 (34.6%)	7 (43.8%)	0.149
Dyslipidaemia	184 (94.8%)*	10 (100%)*	0.462
STEMI	185 (68.0%)	12 (75.0%)	0.058
LVEF, %	52.4±11.19	53.5±13.43	0.743
SYNTAX score	7.83±7.86	8.54±6.89	0.751
SVD	128 (56.4%)†	7 (53.8%)†	0.783
DVD	68 (30.0%)†	1 (7.7%)†	0.476
TVD	31 (13.7%)†	5 (38.5%)†	0.028

DISCUSSION

Principal findings

This study evaluated ABI-defined PAD among patients presenting with ACS in a northern Indian tertiary-care cohort. The principal observations were the substantial burden of conventional cardiovascular risk factors, CTA-confirmed lower-limb atherosclerotic disease in 88.2% of patients with ABI ≤0.90, and the reported distribution of coronary angiographic disease. The PAD subgroup comprised 17 patients.

PAD as a marker of systemic and polyvascular atherosclerosis

PAD is increasingly understood as a manifestation of systemic atherosclerosis rather than an isolated limb disorder. The 2024 ACC/AHA guideline explicitly places ABI-based diagnosis within a broader PAD management pathway, while the 2024 ESC guideline includes a dedicated section on polyvascular PAD and PAD in patients with cardiac disease.[1,2] In an ACS population, the presence of PAD may therefore identify a patient phenotype with disease affecting multiple arterial beds.

ABI and CTA correlation

CTA demonstrated significant lower-limb atherosclerotic disease in 15 of 17 patients (88.2%) with ABI ≤0.90. This finding supports the clinical relevance of an abnormal ABI in this selected subgroup. However, CTA was performed selectively according to ABI; the absence of CTA in patients with normal ABI creates verification bias, and sensitivity, specificity, negative predictive value and an unbiased ROC curve cannot be calculated from the present data.

Coronary disease burden and polyvascular disease

The study's PAD comparison included 17 patients. Table 5 depicts triple-vessel disease in 5 patients in the PAD group and 31 in the non-PAD group, with p=0.028. This association should be interpreted cautiously because coronary angiography was not available for all patients and the small PAD subgroup limits precision. The available summary data does not establish an independent association after adjustment for potential confounders, however we can make out the fact that patients with multivessel disease definitely had an increased preponderance of PAD.

Risk-factor profile

The cohort had high prevalences of smoking and hypertension, with diabetes present in approximately one-third of participants. In the reported PAD comparison, diabetes was numerically more frequent in the PAD group, while most other conventional risk factors did not differ significantly. These comparisons should be interpreted cautiously because the PAD subgroup was small.

Clinical implications

Detection of PAD during an ACS admission may have implications beyond documenting another vascular diagnosis. Contemporary PAD guidance emphasizes comprehensive cardiovascular risk reduction, including lipid lowering, smoking cessation, blood-pressure and diabetes management, physical activity and appropriate antithrombotic therapy according to the overall vascular phenotype and bleeding risk.[1,2] The 2023 ESC ACS guideline similarly emphasizes comprehensive secondary prevention following the index ACS event.[5] ABI assessment may therefore function as a pragmatic method of identifying previously unrecognized systemic atherosclerotic disease in selected ACS patients.

Strengths

Strengths include systematic ABI assessment during the index hospitalization, objective CTA assessment in patients with ABI <1.00, availability of coronary angiographic data in most patients, and inclusion of a relatively understudied northern Indian population. The study also attempts to connect peripheral vascular physiology with coronary anatomical disease rather than treating PAD prevalence as an isolated descriptive endpoint.

Limitations

The study was single-centre and observational, limiting generalizability and precluding causal inference. The PAD subgroup was small, limiting statistical precision. CTA was performed selectively in patients with ABI <1.00, preventing unbiased assessment of diagnostic accuracy. The ABI device used an automated plethysmographic method rather than a conventional Doppler-based vascular laboratory protocol, although automated devices have demonstrated useful diagnostic performance.[13–15] Patients with known PAD were excluded, which may have lowered the observed prevalence. No longitudinal cardiovascular or limb outcomes were available, so prognostic conclusions cannot be drawn. The available summary results do not permit adjusted analyses or a full diagnostic accuracy assessment.

CONCLUSION

In this northern Indian cohort of patients presenting with ACS, ABI-defined PAD was identified in a minority of patients. CTA demonstrated significant lower-limb atherosclerotic disease in 88.2% of patients with ABI ≤0.90 who underwent imaging. These findings support the clinical relevance of peripheral vascular assessment in ACS and warrant confirmation in larger cohorts with systematic imaging and longitudinal follow-up.

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