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Original Research Article

CLINICAL AND ANGIOGRAPHIC PROFILE OF PATIENTS WITH ACUTE MYOCARDIAL INFARCTION WHO UNDERWENT CORONARY ANGIOGRAPHY IN A TERTIARY CARE CENTRE

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ABSTRACT

Background: Aim: To describe the clinical and coronary angiographic profile of patients presenting with acute myocardial infarction and to examine the association of conventional coronary risk factors with the degree and extent of coronary artery disease. **Materials and Methods:** This hospital-based retrospective observational study included 250 consecutive patients with acute myocardial infarction who underwent coronary angiography at Thanjavur Medical College and Hospital between September 2019 and December 2020. Clinical characteristics, conventional risk factors and angiographic findings were abstracted from hospital records. Angiograms were assessed by two independent observers blinded to clinical details. Significant coronary artery disease was defined as ≥70% stenosis of a major epicardial vessel or ≥50% stenosis of the left main coronary artery. Categorical and continuous variables were compared using appropriate chi-square/Fisher's exact, t-test and analysis-of-variance methods. **Results:** The mean age was 52.06 ± 10.81 years and 222 patients (88.8%) were men. Women presented significantly later than men (57.52 ± 8.76 vs 51.39 ± 10.86 years; p = 0.002). Smoking was the commonest risk factor (54.0%), followed by hypertension (38.4%) and diabetes mellitus (33.6%). ST-elevation myocardial infarction accounted for 90.7% of presentations. Significant coronary artery disease was present in 205 patients (82.7%); single-, double- and triple-vessel disease accounted for 57.4%, 23.3% and 19.3%, respectively. The left anterior descending artery was involved in 78.4%. Diabetes, hypertension, dyslipidemia and abdominal obesity showed graded increases across single-, double- and triple-vessel disease (p ≤ 0.024), whereas smoking and family history did not. Dyslipidemia was significantly associated with left anterior descending artery involvement (OR 3.18; p = 0.025). **Conclusion:** Single-vessel disease was the most frequent angiographic pattern in this predominantly male cohort. Metabolic risk factors were associated with greater coronary vessel involvement, while smoking was associated with younger age at presentation rather than greater angiographic extent.

INTRODUCTION

Cardiovascular disease has emerged as the single largest contributor to adult mortality in India. National mortality statistics indicate that coronary artery disease accounted for approximately 17% of total deaths and 26% of adult deaths during 2001-2003, and that these proportions rose to 23% and 32% respectively by 2010-2013. Over the past six decades the prevalence of coronary artery disease has risen from about 1% to 9-10% in urban populations and from under 1% to 4-6% in rural populations, and a further substantial increase is projected.[1-3]

Indians develop coronary artery disease at least a decade earlier than Western European and Latin American populations, and do so in their most productive years, with more extensive and severe angiographic involvement.[4,5] This excess risk has

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been attributed to a combination of genetic predisposition, an adverse metabolic phenotype characterised by high triglycerides and low high-density lipoprotein cholesterol, and a rapidly changing risk factor environment driven by urbanisation, migration from rural to urban areas, sedentary lifestyles, tobacco use and unhealthy dietary patterns.[6]

The INTERHEART study, a large standardised case-control study spanning 52 countries, demonstrated that nine modifiable risk factors like smoking, hypertension, diabetes mellitus, dyslipidemia, abdominal obesity, psychosocial stress, dietary factors, physical inactivity and alcohol consumption accounted for approximately 90% of the population-attributable risk of acute myocardial infarction in men and 94% in women.[7] The same study observed that South Asian men sustaining acute myocardial infarction were on average 5.6 years younger than women.

Although several Indian series have described the angiographic profile of patients with coronary artery disease, most have focused either on unselected catheterisation laboratory populations or on young patients with acute coronary syndrome.[8-11] Studies specifically examining how the conventional risk factor profile relates to the degree of stenosis and to the anatomical distribution of lesions in patients presenting with acute myocardial infarction from predominantly rural catchment areas of South India are comparatively few. Since the majority of patients admitted to our institution are drawn from the surrounding rural districts, the present study was undertaken to describe the clinical characteristics and coronary angiographic profile of patients presenting with acute myocardial infarction, and to correlate conventional coronary risk factors with the degree of coronary stenosis and the distribution of coronary lesions.

MATERIALS AND METHODS

Study design and setting

This hospital-based retrospective observational study was conducted in the Department of Cardiology, Thanjavur Medical Collessge and Hospital, Thanjavur, a tertiary care teaching institution serving a predominantly rural catchment population in the Cauvery delta region of Tamil Nadu.

Study population

Two hundred and fifty consecutive patients admitted with acute myocardial infarction who underwent coronary angiography between September 2019 and December 2020 were included. Patients who underwent coronary angiography for assessment of surgical fitness, such as those with valvular or congenital heart disease, and those who underwent angiography for chronic stable angina or unstable angina, were excluded.

Data collection

All data pertaining to clinical characteristics, conventional coronary risk factors and angiographic findings were abstracted from hospital records using a predesigned proforma. The variables recorded were age, sex, the presence of diabetes mellitus, systemic hypertension, dyslipidemia, smoking, abdominal obesity and family history of coronary artery disease, the clinical presentation (ST-elevation myocardial infarction classified by infarct territory, or non-ST-elevation myocardial infarction), administration of thrombolytic therapy, left ventricular systolic function on echocardiography, and the management strategy advised by the consultant cardiologist.

Diabetes mellitus was recorded when the patient was on treatment for diabetes or had a documented diagnosis in the case record; systemic hypertension when the patient was on antihypertensive therapy or had a documented diagnosis; and dyslipidemia when documented in the record or when the patient was on lipid-lowering therapy. Smoking referred to current or recent regular use of tobacco in smoked form. Abdominal obesity and family history of premature coronary artery disease were recorded as documented in the case records. Left ventricular systolic function was categorised on echocardiography as normal (ejection fraction ≥ 50%), mild (40–49%), moderate (30–39%) or severe (< 30%) dysfunction.

Coronary angiography

Coronary angiography was performed using standard technique with multiple standardised projections. All angiograms were visually assessed by two independent observers blinded to the identity and clinical characteristics of the patients; the angiographic projection at end-diastole in which the lesion appeared most severe was used for grading. Significant coronary artery disease was defined as the presence of at least 70% reduction in luminal diameter of one or more major epicardial coronary arteries, the left anterior descending, left circumflex or right coronary artery or at least 50% luminal diameter stenosis of the left main coronary artery. Patients with lesions below these thresholds were classified as having non-significant coronary artery disease. The vessel classification of the Coronary Artery Surgery Study was used for segmental analysis.[12]

Patients were categorised according to the number of major epicardial vessels involved as having single, double or triple vessel disease, and according to lesion distribution within the left main, left anterior descending, left circumflex and right coronary arteries as ostial, proximal, middle, distal or diffuse. Recanalised coronary arteries were recorded separately. The degree of left main stenosis and the site of left main involvement were documented for every patient in whom the left main coronary artery was diseased.

Statistical analysis

Data were compiled in a spreadsheet and analysed using standard statistical software. Continuous variables are expressed as mean ± standard deviation

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and categorical variables as absolute numbers and percentages. Continuous variables were compared between two groups using the unpaired t test and across three groups using one-way analysis of variance, with pairwise comparisons where the overall test was significant. Categorical variables were compared using the chi-square test, with Fisher's exact test applied where expected cell counts were small. Trends in the prevalence of risk factors across single, double and triple vessel disease were tested using the Cochran-Armitage test for linear trend, and the association between age and the number of vessels involved was assessed using the Spearman rank correlation coefficient. Odds ratios are reported for dichotomous comparisons. A two-tailed p value < 0.05 was considered statistically significant. Denominators for individual analyses vary slightly where a variable was not recorded in the case notes, and are stated in the relevant tables.

Ethical considerations

As this was a retrospective observational study involving less than minimal risk to the study subjects, a waiver of informed consent was obtained. Approval was obtained from the Institutional Ethics Committee of Thanjavur Medical College before commencement of the study, and permission for collection of data from hospital records was obtained from the Dean, Thanjavur Medical College, and the Head of the Department of Cardiology. [Institutional Ethics Committee approval number and approval date 932/2021 dated 20/01/2021.]

RESULTS

Figure 1: Age and sex distribution of the study population

Figure 2: Prevalence of conventional coronary risk factors (n = 250)

Clinical presentation, reperfusion and left ventricular function

ST-elevation myocardial infarction accounted for the overwhelming majority of admissions (226 patients, 90.7%). Anterior wall myocardial infarction was the commonest presentation, seen in 133 patients (53.2%), followed by inferior wall myocardial infarction in 86 (34.7%) and lateral wall myocardial infarction in 7 (2.8%); 24 patients (9.3%) presented with non-ST-elevation myocardial infarction. The distribution of infarct territory did not differ significantly between men and women (p = 0.652) [Table 2, Figure 3].

One hundred and sixty-five patients (66.0% of the cohort) received thrombolytic therapy, representing 73.3% of all patients presenting with ST-elevation myocardial infarction. On echocardiography, left ventricular systolic function was normal in 63 patients (25.3%), while 124 (49.4%) had mild, 62 (24.9%) had moderate and 1 (0.4%) had severe left ventricular dysfunction. Moderate-to-severe left ventricular dysfunction was substantially more frequent after anterior wall infarction than after inferior wall infarction (52/132, 39.4% vs 8/86, 9.3%; p < 0.001).

Table 2: Clinical presentation, reperfusion therapy and left ventricular function

*Clinical presentation not recorded in 2 patients and left ventricular function in 1 patient. STEMI = ST-elevation myocardial infarction; NSTEMI = non-ST-elevation myocardial infarction; LV = left ventricular.

Angiographic profile

A right dominant coronary circulation was present in 228 patients (91.0%), a co-dominant circulation in 13 (5.3%) and a left dominant circulation in 9 (3.7%). Significant coronary artery disease (≥ 70% luminal diameter stenosis in any major epicardial vessel, or ≥ 50% in the left main coronary artery) was demonstrated in 207 patients (82.7%), while 43 patients (17.3%) had non-significant disease. Recanalised coronary arteries were documented in 21 patients (8.6%), all of whom fell within the non-significant coronary artery disease group and accounted for 48.8% of that group [Table 3].

Considering the number of major epicardial vessels involved, single vessel disease was the commonest pattern (144 patients, 57.4%), followed by double vessel disease (58 patients, 23.3%) and triple vessel disease (48 patients, 19.3%) [Figure 3]. When the analysis was restricted to the 207 patients, single vessel disease was present in 106 (51.2%), double vessel disease in 56 (26.8%) and triple vessel disease in 45 (22.0%).

The left anterior descending artery was the vessel most frequently involved, being diseased in 196 patients (78.4%), followed by the right coronary artery in 136 (54.4%), the left circumflex artery in 71 (28.4%) and the left main coronary artery in 15 (6.0%). Among patients with significant coronary artery disease the corresponding figures were 167 (81.5%), 117 (57.1%), 66 (32.2%) and 15 (7.3%) respectively.

Table 3: Angiographic characteristics of the study population

Denominators vary because coronary dominance was not recorded in 5 patients, degree of stenosis in 2 patients and extent of vessel involvement in 1 patient. CAD = coronary artery disease.

Figure 3: Distribution of clinical presentation and extent of coronary vessel involvement

Segment-wise lesion distribution

Within the left anterior descending artery, proximal and mid-segment lesions were equally common, each seen in 129 of the 196 patients with left anterior descending artery involvement (65.8%); distal lesions were found in 17 (8.7%) and diffuse disease in 21 (10.7%). Notably, every patient with left anterior descending artery disease had involvement of the proximal or mid segment. In the right coronary artery, the mid segment was most frequently affected (92/136, 67.6%), followed by the proximal segment (76, 55.9%), distal segment (34, 25.0%) and diffuse disease (28, 20.6%). Left circumflex artery lesions were predominantly proximal (52/71, 73.2%), with

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distal lesions in 26 (36.6%) and diffuse disease in 15 (21.1%). Of the 15 patients with left main coronary artery disease, 12 (80.0%) had distal and 4 (26.7%) had ostial lesions [Table 4, Figure 4].

Lesion distribution corresponded closely with the electrocardiographic territory of infarction. All 133 patients with anterior wall myocardial infarction (100%) had left anterior descending artery involvement, and the right coronary artery was involved in 81 of 86 patients with inferior wall myocardial infarction (94.2%) compared with 55 of 164 patients presenting otherwise (33.5%; $p < 0.001$). The distribution of the extent of disease also varied significantly with the clinical presentation ($p = 0.006$), triple vessel disease being proportionately commonest among patients with non-ST-elevation myocardial infarction (9/24, 37.5%).

Table 4: Segment-wise distribution of coronary lesions

Values are n (%). Percentages for individual segments are calculated among patients in whom that vessel was involved; percentages in the last row are of the whole cohort (n = 250). More than one segment could be involved in the same vessel, so column percentages may exceed 100. LMCA = left main coronary artery; LAD = left anterior descending artery; LCX = left circumflex artery; RCA = right coronary artery.

Figure 4: Segment-wise lesion distribution in the left anterior descending, left circumflex and right coronary arteries

Left main coronary artery disease

Left main coronary artery disease was documented in 15 patients (6.0% of the cohort). The mean degree of left main stenosis in these patients was 56.3 ± 20.7% (range 30-90%). Applying the accepted cut-off of ≥ 50% luminal diameter narrowing, left main disease was haemodynamically significant in 9 of the 15 patients, representing 3.6% of the whole cohort and 4.4% of the 207 patients with significant coronary artery disease; the remaining 6 patients had non-significant left main narrowing of 30-40% [Table 5, Figure 5]. Stenosis was in the 50-69% range in 3 patients, 70-89% in 5 patients and ≥ 90% in 1 patient.

The distal left main segment was involved far more often than the ostium (12 patients, 80.0% vs 4 patients, 26.7%), with a single patient having both ostial and distal disease. Patients with left main involvement were significantly older than the rest of the cohort (57.40 ± 8.23 vs 51.72 ± 10.87 years; $p = 0.021$) and were more likely to present as non-ST-elevation myocardial infarction (4/15, 26.7% vs 19/235, 8.1%; $p = 0.039$), while the sex distribution was comparable ($p = 0.678$).

Left main disease was almost invariably part of an extensive atherosclerotic burden: 12 of the 15 patients (80.0%) had triple vessel disease, compared with 36 of the remaining 235 patients (15.3%; $p < 0.001$). This association was absolute among those with significant left main stenosis, all 9 such patients had concomitant triple vessel disease and all 9 (100%) were referred for coronary artery bypass grafting. Among the 6 patients with non-significant left main narrowing, bypass grafting was advised in 3, in each instance on the basis of the severity of disease in the other epicardial vessels rather than the left main lesion itself.

Table 5: Degree, site and clinical correlates of left main coronary artery disease (n = 15)

Significance of left main disease defined as ≥ 50% luminal diameter stenosis. One patient (serial no. 102) had both ostial and distal involvement, hence site totals exceed 15. LMCA = left main coronary artery; CAD = coronary artery disease; CABG = coronary artery bypass grafting; S = significant; NS = non-significant; SVD = single vessel disease; DVD = double vessel disease; TVD = triple vessel disease; M = male; F = female.

Figure 5: Severity of left main coronary artery stenosis. (A) Degree of stenosis in each of the 15 affected patients, ranked by severity; the dashed line marks the 50% threshold for haemodynamically significant left main disease. (B) Distribution of patients across stenosis severity categories.

Correlation of risk factors with the degree of coronary stenosis

Patients with significant coronary artery disease were significantly older than those with non-significant disease (52.77 ± 10.47 vs 48.70 ± 11.60 years; $p = 0.038$). None of the six conventional risk factors was individually associated with the presence of significant stenosis, although diabetes mellitus (36.1% vs 20.9%; $p = 0.074$, OR 2.13) and a family history of coronary artery disease (21.0% vs 9.3%; $p = 0.088$, OR 2.59) showed trends towards significance. Smoking was numerically more frequent in the non-significant disease group (62.8% vs 51.7%; $p = 0.239$). The mean number of risk factors carried did not differ between the two groups (1.88 ± 1.36 vs 1.60 ± 1.12; $p = 0.151$), and the sex distribution and infarct territory were also comparable ($p = 0.795$ and $p = 0.690$ respectively) [Table 6].

Table 6: Comparison of patients with significant and non-significant coronary artery disease

Values are n (%) unless otherwise stated. p values by unpaired t test for age and by chi-square or Fisher's exact test for categorical variables. Degree of stenosis was not recorded in 2 patients. CAD = coronary artery disease; OR = odds ratio.

Correlation of risk factors with the extent of vessel involvement

The extent of coronary involvement showed a strong and graded relationship with both age and metabolic risk factors [Table 7, Figure 6]. Mean age rose progressively from 48.81 ± 10.49 years in single vessel disease to 55.41 ± 10.58 years in double vessel disease and 57.71 ± 8.39 years in triple vessel disease (ANOVA, $p < 0.001$); patients with single vessel disease were significantly younger than those with double vessel disease ($p < 0.001$) and triple vessel disease ($p < 0.001$), whereas double and triple vessel disease groups did not differ from each other ($p =$

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0.216). Age correlated positively with the number of vessels involved (Spearman rho = 0.360; p < 0.001).

The prevalence of diabetes mellitus increased from 21.7% in single vessel disease to 41.4% in double vessel disease and 60.4% in triple vessel disease (p < 0.001; test for trend p < 0.001). Similar graded increases were observed for systemic hypertension (30.8%, 41.4% and 58.3%; p = 0.003), dyslipidemia (16.8%, 20.7% and 35.4%; p = 0.024) and abdominal obesity (9.8%, 24.1% and 25.0%; p = 0.007). In contrast, neither smoking (53.1%, 48.3% and 62.5%; p = 0.333) nor family history of coronary artery disease (18.2%, 20.7% and 20.8%; p = 0.878) was related to the extent of disease. Women were over-represented in the multivessel disease groups (p < 0.001).

When patients were dichotomised into multivessel disease (double or triple vessel disease, n = 106) and single vessel disease (n = 144), diabetes mellitus (OR 3.65; p < 0.001), abdominal obesity (OR 2.79; p = 0.003), systemic hypertension (OR 2.19; p = 0.004) and dyslipidemia (OR 1.88; p = 0.044) were all significantly associated with multivessel involvement. Patients with multivessel disease carried a significantly greater burden of conventional risk factors than those with single vessel disease (2.26 ± 1.33 vs 1.50 ± 1.23; p < 0.001).

Table 7: Relationship of age, sex and risk factors to the extent of coronary vessel involvement

Values are n (%) unless otherwise stated. p values by one-way ANOVA for age and chi-square test for categorical variables; p trend by Cochran-Armitage test for linear trend across SVD → DVD → TVD. Extent of vessel involvement was not recorded in 1 patient. SVD = single vessel disease; DVD = double vessel disease; TVD = triple vessel disease; CAD = coronary artery disease.

Figure 6: Prevalence of conventional risk factors according to the extent of coronary vessel involvement

Correlation of risk factors with lesion distribution

Patients with left anterior descending artery involvement (n = 196) were compared with those in whom this vessel was spared (n = 54) [Table 8]. Dyslipidemia was the only risk factor significantly associated with left anterior descending artery disease (24.5% vs 9.3%; p = 0.025, OR 3.18). Mean age (52.49 ± 10.70 vs 50.49 ± 11.16 years; p = 0.247), male sex (86.7% vs 96.3%; p = 0.052), diabetes mellitus (p = 0.390), hypertension (p = 0.480), smoking (p = 0.680), abdominal obesity (p = 0.328) and family history of coronary artery disease (p = 0.466) did not differ significantly between the two groups. Since all patients with left anterior descending artery disease had proximal or mid-segment lesions, an identical result was obtained when the comparison was framed as proximal/mid-left anterior descending artery lesions versus non-left anterior descending artery lesions.

Table 8: Comparison of patients with and without left anterior descending artery involvement

Values are n (%) unless otherwise stated. LAD = left anterior descending artery; CAD = coronary artery disease; OR = odds ratio.

Mode of treatment

Percutaneous transluminal coronary angioplasty was the commonest management strategy, undertaken in 170 patients (68.0%); the target vessel was the left anterior descending artery in 111 patients (44.4%), the right coronary artery in 68 (27.2%) and the left circumflex artery in 15 (6.0%), with 24 patients (14.1% of those undergoing angioplasty) receiving intervention to more than one vessel. Coronary artery bypass grafting was advised in 38 patients (15.2%) and optimal medical therapy alone in 42 (16.8%).

The management strategy was closely related to the angiographic findings [Table 9]. Angioplasty was performed in 109 of 144 patients with single vessel disease (76.2%) and 53 of 58 with double vessel disease (91.4%), whereas bypass grafting was reserved almost exclusively for triple vessel disease (36/48, 75.0%). Optimal medical therapy was largely confined to patients with non-significant coronary artery disease (41 of 42 patients treated medically, 97.6%).

Table 9: Mode of treatment according to the extent of coronary vessel involvement

Values are n (%). Column percentages are of patients in that vessel-involvement category. One patient was recorded as having received both angioplasty and optimal medical therapy. Extent of vessel involvement was not recorded in 1 patient. PTCA = percutaneous transluminal coronary angioplasty; CABG = coronary artery bypass grafting; LAD = left anterior descending artery; RCA = right coronary artery; LCX = left circumflex artery; SVD = single vessel disease; DVD = double vessel disease; TVD = triple vessel disease.

Table 1: Demographic profile and coronary risk factors of the study population (n = 250)

Variable	Total (n = 250)	Men (n = 222)	Women (n = 28)	p value
Age, years (mean ± SD)*	52.06 ± 10.81	51.39 ± 10.86	57.52 ± 8.76	0.002
Age ≤ 45 years	68 (27.2)	66 (29.7)	2 (7.1)	0.012
Risk factors, n (%)				
Smoking	135 (54.0)	135 (60.8)	0 (0)	<0.001
Systemic hypertension	96 (38.4)	81 (36.5)	15 (53.6)	0.099
Diabetes mellitus	84 (33.6)	69 (31.1)	15 (53.6)	0.032
Dyslipidemia	53 (21.2)	42 (18.9)	11 (39.3)	0.024
Family history of CAD	48 (19.2)	43 (19.4)	5 (17.9)	1.000
Abdominal obesity	41 (16.4)	28 (12.6)	13 (46.4)	<0.001

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Number of risk factors (mean ± SD)	1.83 ± 1.33	1.79 ± 1.32	2.11 ± 1.37	0.259
No conventional risk factor	33 (13.2)	30 (13.5)	3 (10.7)	1.000

Table 2: Clinical presentation, reperfusion therapy and left ventricular function

Variable	n	%	Remarks
Clinical presentation (n = 248)*			
STEMI – anterior wall	133	53.2	-
STEMI – inferior wall	86	34.7	-
STEMI – lateral wall	7	2.8	-
NSTEMI	24	9.3	-
Total STEMI	226	90.7	-
Thrombolysis (n = 250)			
Thrombolysed	165	66.0	73.3% of STEMI
Not thrombolysed	85	34.0	-
LV systolic function (n = 249)			
Normal	63	25.3	-
Mild dysfunction	124	49.4	-
Moderate dysfunction	62	24.9	-
Severe dysfunction	1	0.4	-

Table 3: Angiographic characteristics of the study population

Variable	n	%	Denominator
Coronary dominance			
Right dominant	228	91.0	n = 250
Co-dominant	13	5.3	n = 250
Left dominant	9	3.7	n = 250
Degree of coronary stenosis			
Significant CAD	207	82.7	n = 250
Non-significant CAD	43	17.3	n = 250
Recanalised coronaries	21	8.6	n = 250
Extent of vessel involvement			
Single vessel disease	144	57.4	n = 250
Double vessel disease	58	23.3	n = 250
Triple vessel disease	48	19.3	n = 250
Vessel involved			
Left anterior descending artery	196	78.4	n = 250
Right coronary artery	136	54.4	n = 250
Left circumflex artery	71	28.4	n = 250
Left main coronary artery	15	6.0	n = 250

Table 4: Segment-wise distribution of coronary lesions

Segment	LMCA (n = 15)	LAD (n = 196)	LCX (n = 71)	RCA (n = 136)
Ostial	4 (26.7)	-	-	-
Proximal	-	129 (65.8)	52 (73.2)	76 (55.9)
Middle	-	129 (65.8)	-	92 (67.6)
Distal	12 (80.0)	17 (8.7)	26 (36.6)	34 (25.0)
Diffuse	-	21 (10.7)	15 (21.1)	28 (20.6)
Vessel not involved	235 (94.0)	54 (21.6)	179 (71.6)	114 (45.6)

Table 5: Degree, site and clinical correlates of left main coronary artery disease (n = 15)

Serial no.	Age (y)	Sex	LMCA stenosis (%)	Site of involvement	Significance	Extent of CAD	CABG
5	58	M	30-40	Distal	NS	DVD	No
48	46	F	70	Ostial	S	TVD	Yes
56	60	M	70	Distal	S	TVD	Yes
64	70	M	30-40	Distal	NS	TVD	Yes
65	60	M	60	Distal	S	TVD	Yes
75	55	M	80	Distal	S	TVD	Yes
76	67	M	40	Distal	NS	TVD	Yes
96	59	M	30	Distal	NS	TVD	Yes
99	61	M	60	Distal	S	TVD	Yes
102	65	F	80-90	Ostial and distal	S	TVD	Yes
113	47	M	90	Distal	S	TVD	Yes
115	65	M	70	Distal	S	TVD	Yes
135	45	M	30	Distal	NS	DVD	No
166	45	M	30	Ostial	NS	SVD	No
178	58	M	60	Ostial	S	TVD	Yes

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Summary	57.40 ± 8.23	13 M / 2 F	56.3 ± 20.7	Distal 12 / Ostial 4	S 9 (60.0%)	TVD 12 (80.0%)	12 (80.0%)

Table 6: Comparison of patients with significant and non-significant coronary artery disease

Variable	Significant CAD (n = 207)	Non-significant CAD (n = 43)	p value	OR
Age, years (mean ± SD)	52.77 ± 10.47	48.70 ± 11.60	0.038	-
Male sex	181 (88.3)	39 (90.7)	0.795	0.77
Diabetes mellitus	74 (36.1)	9 (20.9)	0.074	2.13
Systemic hypertension	82 (40.0)	13 (30.2)	0.301	1.54
Dyslipidemia	45 (22.0)	7 (16.3)	0.537	1.45
Smoking	106 (51.7)	27 (62.8)	0.239	0.63
Abdominal obesity	35 (17.1)	6 (14.0)	0.822	1.27
Family history of CAD	43 (21.0)	4 (9.3)	0.088	2.59
Number of risk factors (mean ± SD)	1.88 ± 1.36	1.60 ± 1.12	0.151	-
Recanalised coronaries	0 (0)	21 (48.8)	<0.001	-

Table 7: Relationship of age, sex and risk factors to the extent of coronary vessel involvement

Variable	SVD (n = 144)	DVD (n = 58)	TVD (n = 48)	p value	p trend
Age, years (mean ± SD)	48.81 ± 10.49	55.41 ± 10.58	57.71 ± 8.39	<0.001	<0.001
Female sex	7 (4.9)	15 (25.9)	6 (12.5)	<0.001	0.014
Diabetes mellitus	31 (21.7)	24 (41.4)	29 (60.4)	<0.001	<0.001
Systemic hypertension	44 (30.8)	24 (41.4)	28 (58.3)	0.003	<0.001
Dyslipidemia	24 (16.8)	12 (20.7)	17 (35.4)	0.024	0.010
Abdominal obesity	14 (9.8)	14 (24.1)	12 (25.0)	0.007	0.004
Smoking	76 (53.1)	28 (48.3)	30 (62.5)	0.333	0.410
Family history of CAD	26 (18.2)	12 (20.7)	10 (20.8)	0.878	0.638
Number of risk factors (mean ± SD)	1.50 ± 1.23	1.97 ± 1.27	2.62 ± 1.33	<0.001	<0.001

Table 8: Comparison of patients with and without left anterior descending artery involvement

Variable	LAD involved (n = 196)	LAD not involved (n = 54)	p value	OR
Age, years (mean ± SD)	52.49 ± 10.70	50.49 ± 11.16	0.247	-
Male sex	170 (86.7)	52 (96.3)	0.052	0.25
Dyslipidemia	48 (24.5)	5 (9.3)	0.025	3.18
Diabetes mellitus	69 (35.2)	15 (27.8)	0.390	1.41
Systemic hypertension	78 (39.8)	18 (33.3)	0.480	1.32
Abdominal obesity	35 (17.9)	6 (11.1)	0.328	1.74
Family history of CAD	40 (20.4)	8 (14.8)	0.466	1.47
Smoking	104 (53.1)	31 (57.4)	0.680	0.84
Number of risk factors (mean ± SD)	1.91 ± 1.36	1.54 ± 1.18	0.050	-

Table 9: Mode of treatment according to the extent of coronary vessel involvement

Treatment	SVD (n = 144)	DVD (n = 58)	TVD (n = 48)	Total (n = 250)
PTCA (any vessel)	109 (76.2)	53 (91.4)	8 (16.7)	170 (68.0)
PTCA to LAD	-	-	-	111 (44.4)
PTCA to RCA	-	-	-	68 (27.2)
PTCA to LCX	-	-	-	15 (6.0)
CABG	0 (0)	2 (3.4)	36 (75.0)	38 (15.2)
Optimal medical therapy	35 (23.8)	3 (5.2)	4 (8.3)	42 (16.8)

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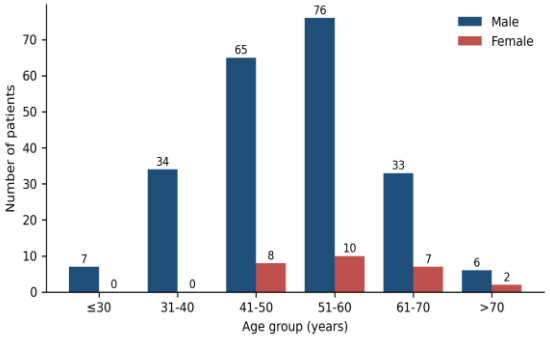


Figure 1: Age and sex distribution of the study population

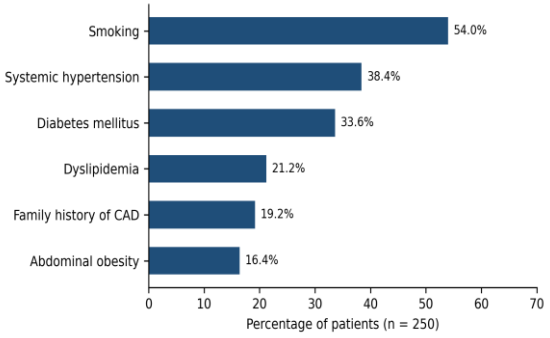


Figure 2: Prevalence of conventional coronary risk factors (n = 250)

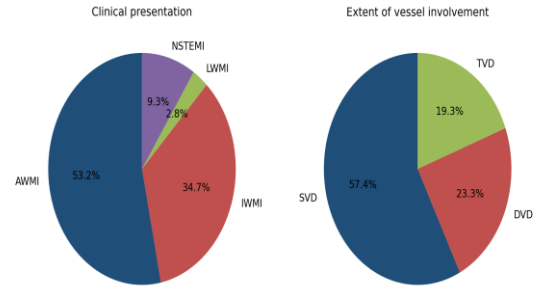


Figure 3: Distribution of clinical presentation and extent of coronary vessel involvement

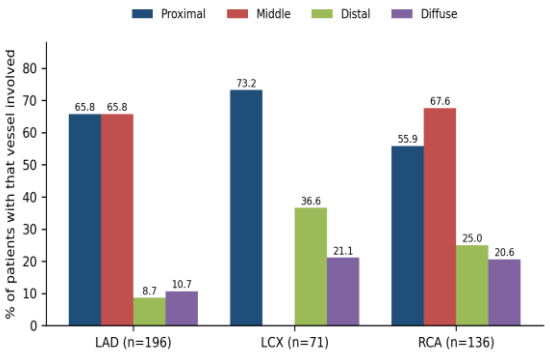


Figure 4: Segment-wise lesion distribution in the left anterior descending, left circumflex and right coronary arteries

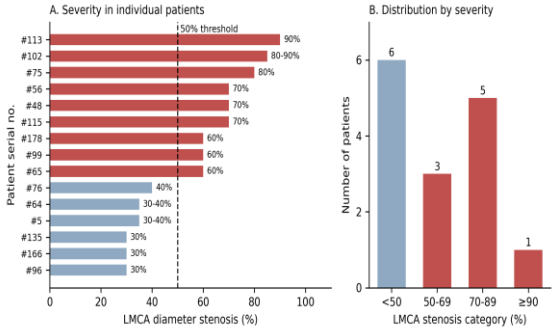


Figure 5: Severity of left main coronary artery stenosis. (A) Degree of stenosis in each of the 15 affected patients, ranked by severity; the dashed line marks the 50% threshold for haemodynamically significant left main disease. (B) Distribution of patients across stenosis severity categories

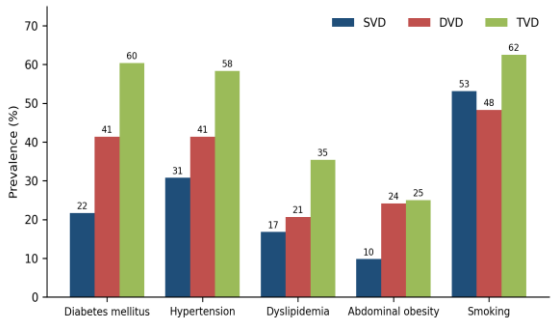


Figure 6: Prevalence of conventional risk factors according to the extent of coronary vessel involvement

DISCUSSION

The present study describes the clinical and angiographic profile of 250 consecutive patients presenting with acute myocardial infarction to a tertiary care centre serving a predominantly rural population in South India. Three findings deserve emphasis. First, single vessel disease was the dominant angiographic pattern, and the population was overwhelmingly male and comparatively young. Second, the metabolic risk factors like diabetes mellitus, systemic hypertension, dyslipidemia and abdominal obesity showed a consistent, graded relationship with the extent of coronary involvement, whereas smoking did not. Third, smoking, the commonest risk factor in this cohort, was associated with an earlier age at presentation rather than with more extensive disease.

Age and sex distribution

The mean age at presentation of 52.06 ± 10.81 years in our cohort is approximately four years lower than the 56.16 ± 10.51 years reported by Kumar et al. from Ludhiana in a series of 846 patients with first acute myocardial infarction, and is consistent with the widely reported observation that coronary artery disease manifests earlier in Indians than in Western populations.4,8 More than a quarter of our patients (27.2%) sustained their infarction at or before the age of 45 years, a proportion that reflects the substantial burden of premature coronary artery disease in this

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region and is in keeping with earlier Indian angiographic series.[13]

The marked male preponderance in our study (88.8%) exceeds the 83.3% reported by Kumar et al.8 and the 85.1% and 84.3% reported respectively by Narayanaswamy et al. and Kumbhalkar and Bisne in younger cohorts.[9,11] Part of this excess is likely to be genuine, reflecting the protective effect of the premenopausal hormonal milieu, but referral bias and the atypical symptomatology with which women more often present are also likely to contribute to under-representation of women in angiographic series.[14,15] Consistent with the INTERHEART observation that South Asian men sustain myocardial infarction several years earlier than women,7 the women in our cohort were on average six years older than the men at presentation (57.52 vs 51.39 years; p = 0.002), and no woman presented before the age of 42 years.

Risk factor profile

Smoking was the most prevalent risk factor in our cohort, affecting 54.0% of patients, a strikingly higher prevalence than the 16.5% reported by Kumar et al. from Punjab, where cultural and religious factors substantially reduce tobacco use, and than the 17.1% reported by Kumbhalkar and Bisne from central India.[8,11] Smoking in our series was confined entirely to men. Importantly, smokers presented approximately three years earlier than non-smokers (50.78 vs 53.56 years; p = 0.042), reproducing an association reported consistently in both Indian and Western series.[8,13,16] The exceptionally high prevalence of tobacco use in a rural South Indian population presenting with myocardial infarction highlights the importance of smoking cessation as a key preventive measure in this setting.

Diabetes mellitus was present in 33.6% and systemic hypertension in 38.4% of our patients, both somewhat lower than the 40.4% and 45.7% reported from Ludhiana,8 but considerably higher than the prevalence reported in younger cohorts.[9,11] Patients with diabetes, hypertension, dyslipidemia or abdominal obesity were all significantly older than those without, whereas smokers were significantly younger. This divergence is biologically coherent: the metabolic risk factors act over years to produce diffuse, chronic atherosclerosis, whereas smoking acts more acutely through endothelial dysfunction, enhanced platelet aggregability and plaque instability to precipitate infarction on a less extensively diseased coronary tree.[16] Abdominal obesity, present in 16.4% of our patients, has been shown to be an independent predictor of acute coronary events in middle-aged men, with the risk multiplying several-fold in combination with smoking.[17]

The sex-specific risk factor profile in our cohort was distinctive. Diabetes mellitus, dyslipidemia and abdominal obesity were all significantly more frequent among women, and hypertension was more common although the difference did not reach significance. A comparable female preponderance of diabetes and hypertension was reported by Kumar et al.8 In this cohort, women had a higher prevalence of diabetes, dyslipidemia and abdominal obesity and presented at an older age, whereas smoking was confined to men and was associated with younger age at presentation.

Clinical presentation and left ventricular function

Anterior wall infarction was the commonest presentation (53.2%), followed by inferior wall infarction (34.7%), a distribution closely comparable to the 57.3% and 35.3% reported by Kumar et al,[8] and to other Indian series.9,10 Two-thirds of our patients received thrombolytic therapy, a considerably higher proportion than the 34.6% reported by Tewari et al. from North India and higher also than the 40.8% reported from Ludhiana.8,13 In the absence of a round-the-clock primary angioplasty service, pharmacological reperfusion remains the mainstay of acute management in this setting, and the high thrombolysis rate suggests that first-contact care and referral pathways in the district are functioning reasonably well.

Moderate-to-severe left ventricular dysfunction was four times as frequent after anterior as after inferior wall infarction (39.4% vs 9.3%; p < 0.001), reflecting the larger myocardial mass subtended by the left anterior descending artery and reinforcing the prognostic importance of proximal disease in this vessel.

Angiographic profile

Significant coronary artery disease was demonstrated in 82.7% of our patients, with the remaining 17.3% having non-significant disease; recanalised coronary arteries accounted for nearly half of the latter group. Narayanaswamy et al. reported recanalised coronaries in 18.1% of young patients with acute coronary syndrome,9 and Kumbhalkar and Bisne found normal coronary angiograms in 24.3% of their young cohort.[11] The proportion of patients with angiographically non-obstructive disease in our older cohort is therefore intermediate, as would be expected.

Single vessel disease was the commonest pattern (57.4%), followed by double (23.3%) and triple vessel disease (19.3%). This distribution is broadly similar to the 42.7%, 31.3% and 26.0% reported by Kumar et al.,8 with a greater preponderance of single vessel disease in our series, consistent with our younger mean age. In contrast, Narayanaswamy et al. found nearly equal proportions of single and double vessel disease with only 6.6% triple vessel disease in patients under 45 years,9 and Kumbhalkar and Bisne reported 57.1% single vessel disease in patients under 35 years.[11] Taken together, these series describe a coherent gradient in which the extent of coronary involvement increases progressively with the age of the population studied.

The left anterior descending artery was the vessel most frequently involved (78.4%), followed by the right coronary artery (54.4%) and the left circumflex artery (28.4%), a hierarchy reported almost universally in studies of both young and older patients with acute coronary syndrome.[9,11,19,22]

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Notably, every patient with left anterior descending artery disease in our cohort had proximal or mid-segment involvement, the segments that carry the highest severity coefficient in the Gensini scoring system and the greatest amount of jeopardised myocardium.[18] Lesion distribution corresponded closely with the electrocardiographic territory of infarction: all patients with anterior wall infarction had left anterior descending artery disease, and the right coronary artery was involved in 94.2% of those with inferior wall infarction.

Risk factors and the extent of coronary involvement

The central finding of this study is the graded relationship between the metabolic risk factors and the extent of coronary involvement. The prevalence of diabetes mellitus rose from 21.7% in single vessel disease to 41.4% in double and 60.4% in triple vessel disease ($p < 0.001$ for trend), with parallel gradients for systemic hypertension, dyslipidemia and abdominal obesity. Diabetes conferred a nearly fourfold odds of multivessel disease. This closely reproduces the observation of Kumar et al., who found triple vessel disease in 32.95% of diabetics compared with 21.2% of non-diabetics, and who identified diabetes and older age as predictors of diffuse disease.8 The mechanisms underlying accelerated atherogenesis in diabetes accumulation of advanced glycation end products, impaired endothelium-dependent vasodilatation and increased leucocyte adhesion to vascular endothelium are well described and account for the diffuse, multivessel pattern observed.

Equally instructive is what did not correlate with the extent of disease. Neither smoking nor family history of coronary artery disease showed any relationship with the number of vessels involved ($p = 0.333$ and $p = 0.878$ respectively), despite smoking being the most prevalent risk factor in the cohort. Kapoor et al. similarly reported that younger patients, non-diabetics and smokers tended to have single vessel disease.[10] The clinical implication is that smoking and the metabolic risk factors influence different aspects of the disease: smoking determines when the infarction occurs, while the metabolic factors determine how much coronary artery disease has accumulated by that time.

Consistent with this interpretation, the cumulative burden of risk factors was significantly greater in patients with multivessel disease than in those with single vessel disease (2.62 ± 1.33 vs 1.50 ± 1.23; $p < 0.001$), and age correlated positively with the number of vessels involved. Notably, none of the six risk factors was individually associated with the presence of significant as opposed to non-significant stenosis, and 13.2% of patients had none of the conventional risk factors studied. This substantial residual group is consistent with reports that a considerable proportion of Indian patients with premature coronary artery disease have no conventional risk factor, and supports the case for evaluating non-traditional markers such as lipoprotein (a), homocysteine and plasma fibrinogen, which have been shown to be elevated in a high proportion of young Indian patients with ischaemic heart disease.[11]

Left main coronary artery disease

Left main coronary artery disease was present in 15 patients (6.0%), and was haemodynamically significant in 9 (3.6% of the cohort). Kumbhalkar and Bisne recorded no left main involvement in their cohort of very young patients, and other series have reported a similarly low prevalence in young populations.[11] The prevalence in our older cohort is therefore consistent with the expected age gradient. Distal left main involvement was three times as frequent as ostial involvement, and the association with extensive disease elsewhere was striking: 80% of patients with any left main disease and all nine patients with significant left main stenosis had concomitant triple vessel disease. All nine were referred for coronary artery bypass grafting, and left main involvement was also associated with older age and with a non-ST-elevation presentation. Left main disease in this cohort was associated with extensive disease elsewhere and, when significant, with referral for surgical revascularisation.

Lesion distribution and dyslipidemia

When patients with and without left anterior descending artery involvement were compared, dyslipidemia was the only risk factor significantly associated with disease in this vessel (24.5% vs 9.3%; odds ratio 3.18; $p = 0.025$). Kumbhalkar and Bisne likewise found that the low-density to high-density lipoprotein cholesterol ratio, a positive family history of premature coronary artery disease and tobacco intake were significantly associated with proximal or mid left anterior descending artery lesions in young patients.[11] Hughes et al. demonstrated an increased relative risk of myocardial infarction in Asian Indians directly with triglyceride levels and inversely with high-density lipoprotein cholesterol.20 The prevalence of dyslipidemia recorded in our cohort (21.2%) is likely to be a substantial underestimate, since Indian patients undergoing coronary revascularisation have been shown to carry a far higher burden of lipid abnormality when formally measured.[21] The association observed here, in a cohort in which dyslipidemia was recorded only as a documented dichotomous diagnosis, is therefore likely to understate the true relationship, and lends support to aggressive lipid-lowering therapy in patients with left anterior descending artery disease.

Management

Percutaneous coronary intervention was the commonest management strategy (68.0%), with the left anterior descending artery the most frequent target vessel, while bypass grafting was advised in 15.2% and medical therapy alone in 16.8%. These proportions are broadly comparable with the 48.7%, 20.6% and 30.5% reported by Narayanaswamy et al.9 The management strategy was determined almost entirely by the angiographic findings: angioplasty was undertaken in 76.2% of patients with single vessel disease and 91.4% of those with double vessel disease, bypass grafting was reserved almost

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exclusively for triple vessel and significant left main disease, and medical therapy alone was confined almost entirely to patients with non-significant coronary artery disease. This pattern describes the close relationship between angiographic findings and the management strategy used in this cohort.

Limitations

Several limitations should be acknowledged. First, this was a retrospective single-centre study, and the data were abstracted from hospital records rather than collected prospectively, so risk factors that were not documented may have been under-recorded. Second, risk factors were captured as dichotomous variables; quantitative lipid values, blood pressure readings, glycaemic indices and anthropometric measurements were not available, precluding the analysis of lipid subfractions and ratios that other workers have found informative. Abdominal obesity was recorded as documented rather than by waist circumference or waist–hip ratio, the latter being a better marker of central adiposity in Indian populations. Third, non-traditional risk factors such as lipoprotein (a), homocysteine and plasma fibrinogen were not assessed, and dietary habits, physical activity, psychosocial stress and alcohol consumption were not captured. Fourth, patients who died before angiography could be performed, and those managed conservatively without angiography, were not included, introducing a survival and selection bias that probably excludes the most severe presentations. Fifth, quantitative coronary angiography was not used; lesion severity was assessed visually by two independent observers, and no formal severity score such as the Gensini or SYNTAX score was computed. Finally, in-hospital and follow-up outcomes were not recorded, so the prognostic significance of the angiographic patterns described cannot be assessed. A prospective study incorporating quantitative angiography, complete biochemical profiling and clinical follow-up would address several of these shortcomings.

CONCLUSION

In this cohort of 250 patients presenting with acute myocardial infarction to a tertiary care centre in South India, the population was predominantly male and comparatively young, with more than a quarter presenting at or before 45 years of age. Smoking was the most prevalent risk factor and was associated with an earlier age at presentation, but not with more extensive coronary disease. In contrast, diabetes mellitus, systemic hypertension, dyslipidemia and abdominal obesity showed consistent graded associations with the extent of coronary involvement, and the cumulative burden of risk factors was greater among patients with multivessel disease than among those with single-vessel disease. Single vessel disease involving the left anterior descending artery was the commonest angiographic pattern, and significant left main disease, although uncommon, was invariably accompanied by triple vessel disease. These findings argue for two complementary preventive priorities in this population: sustained population-level tobacco control to defer the age of first infarction, and systematic detection and treatment of metabolic risk factors to limit the extent of coronary atherosclerosis and the consequent need for surgical revascularisation.

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Conflicts of Interest Statement

The authors declare that they have no financial or personal conflicts of interest relevant to this study.

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