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Young Versus Older Patients with ST-Segment Elevation Myocardial Infarction (STEMI): A Single-Center Study

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Abstract

Background: Indians experience acute ST-elevation myocardial infarction (STEMI) at younger ages, with a distinctive pattern of dyslipidemia and emerging risk factors such as lipoprotein(a) and homocysteine. Whether young STEMI patients (<40 years) exhibit a specific clustering of conventional and novel risk factors and a characteristic coronary anatomy compared with older patients is clinically relevant for targeted prevention.
Hypothesis: We hypothesized that younger STEMI patients would demonstrate a higher burden of modifiable risk factors (smoking, overweight, family history of premature coronary artery disease), enrichment of novel risk markers (lipoprotein[a], homocysteine, hsCRP), and predominantly single-vessel disease involving the left anterior descending (LAD) artery, compared with older patients.

Materials and methods: In this prospective observational study, 150 consecutive acute STEMI patients admitted between June 2020 and June 2021 were enrolled and stratified into a younger group (<40 years; n=33) and an older group (≥40 years; n=117). Demographics, clinical presentation, first medical contact, baseline investigations (complete blood count, fasting glucose, HbA1c, lipid profile, renal function), novel risk markers (lipoprotein[a], homocysteine, hsCRP), echocardiographic parameters, and coronary angiographic findings were recorded according to predefined protocols. Univariate comparisons between age groups were performed using chi-square and t-tests.

Results: Younger patients were predominantly male (87.8%), more frequently overweight, and more likely to have a family history of premature CAD and elevated lipoprotein(a), whereas hypertension and higher hsCRP were concentrated in older patients. Both groups exhibited the Indian pattern of high triglycerides with relatively modest HDL-cholesterol. Anterior wall STEMI and single-vessel disease were more common in younger patients, with LAD involvement predominating; older patients more often had multivessel disease and right coronary artery involvement. In-hospital outcomes were favorable overall.

Conclusions: Young South Indian STEMI patients display a distinct risk-factor cluster—overweight, smoking, family history, elevated lipoprotein(a), and TG-rich dyslipidemia with predominantly single-vessel LAD disease. Older patients show higher inflammatory burden and more extensive multivessel involvement. These age-stratified differences support aggressive, early risk-factor screening in young adults and comprehensive secondary prevention across all ages.

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Keywords: ST-elevation myocardial infarction; Young adults; lipoprotein(a); hsCRP; Triglycerides; Coronary angiography; South Asian population.

Introduction

Acute STEMI remains a major contributor to cardiovascular morbidity and mortality worldwide, and the Indian subcontinent bears a disproportionate share of this burden with events occurring 5–10 years earlier than in western populations (1). South Asians demonstrate higher prevalence of conventional risk factors and a characteristic lipid pattern of elevated triglycerides and relatively low HDL-cholesterol, alongside emerging markers such as lipoprotein(a), homocysteine and hsCRP (2). Prior studies have described clinical and angiographic profiles of young ACS patients, but data that simultaneously integrate conventional risk factors, novel biomarkers and coronary anatomy in young versus older STEMI cohorts from South India are limited (3-12). Furthermore, contemporary quality metrics in STEMI emphasize ischemic time, reperfusion modality and early outcomes, which are less well reported from South Asian cohorts (11-21). We hypothesized that younger STEMI patients (<40 years) would exhibit a distinct clustering of conventional and emerging risk factors and a characteristic coronary pattern predominantly single-vessel LAD disease compared with older patients (≥40 years). The primary objective was to compare clinical, biochemical and angiographic profiles between these age groups. Secondary objectives were to describe echocardiographic findings, reperfusion strategies and in-hospital outcomes.

Methods

Study design and setting

This single-center, prospective observational study was conducted in the Department of Cardiology, Nizam's Institute of Medical Sciences, Hyderabad, between June 2020 and June 2021. The study was performed in accordance with institutional ethical clearance and written informed consent was obtained from all participants.

Study population

Consecutive patients presenting with acute STEMI, defined according to the Fourth Universal Definition of Myocardial Infarction (typical ischemic chest pain, ST-segment elevation on ECG, and rise/fall in cardiac troponin above the 99th percentile), were screened.

Inclusion criteria:

- Age ≥30 years.
- Diagnosis of acute STEMI as per guideline criteria.
- Coronary angiography performed within 48 hours of admission.
- Informed consent for participation.
- Exclusion criteria:
- History of prior MI or CABG.
- Known congenital heart disease or stent-related MI.
- Chronic kidney disease, chronic liver disease, malignancy, chronic infectious disease.
- Therapy with drugs known to significantly alter serum glucose or lipid levels.

Patients were stratified into two groups: younger (<40 years; n=33) and older (≥40 years; n=117).

Clinical data collection

Demographic data (age, sex), presenting symptoms (chest pain, breathlessness, syncope, palpitations), and clinical examination findings were recorded using a standardized proforma. Killip class at presentation was documented.

Cardiovascular risk factors included:

- Smoking (current/ex-smoker as per CDC definitions).
- Hypertension (ACC/AHA criteria or use of antihypertensive medications).
- Diabetes mellitus (ADA criteria; fasting plasma glucose ≥126 mg/dL, HbA1c ≥6.5%, or OGTT/random glucose diagnostic thresholds).
- Overweight/obesity (BMI categories per ACC/AHA and WHO guidelines).
- Family history of premature CAD (father <55 years, mother <65 years).[1]
- Alcohol use (self-reported regular intake). (22)

First medical contact and type of reperfusion strategy (primary PCI, pharmaco invasive PCI, thrombolysis; CABG; medical management) were recorded. Detailed time metrics (first medical contact-to-device, door-to-needle, door-to-balloon, total ischemic time) were not systematically captured and are acknowledged as missing.

Laboratory investigations and novel biomarkers

All patients underwent baseline laboratory evaluation including:

- Complete blood count (hemoglobin, total leukocyte count).
- Fasting blood sugar and HbA1c.
- Renal function (urea, creatinine) and serum electrolytes.
- Lipid profile: total cholesterol, LDL-C, HDL-C, triglycerides.
- Emerging risk factors (23) were measured as follows:

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- hsCRP by immunoturbidimetric method.
- Lipoprotein(a) by immunoturbidimetric method.
- Homocysteine (total) by chemiluminescence immunoassay.

Echocardiography

Echocardiography was performed using a Philips EPIQ 7 ultrasound system (X5-1 transducer). Two-dimensional, M-mode and Doppler imaging were obtained from parasternal long and short axis views and apical two- to five-chamber views.

Left ventricular ejection fraction (LVEF) was calculated by Simpson's biplane method and categorized as:

- Moderate LV dysfunction: EF 30–44%.
- Mild LV dysfunction: EF 45–54%.
- Normal: EF ≥55%.

No systematic diastolic function or strain analysis was performed.

Coronary angiography

Coronary angiography was performed via radial or femoral access using standard Judkins catheters. Coronary artery disease extent was classified as (24):

- Single-vessel disease (SVD).
- Double-vessel disease (DVD).
- Triple-vessel disease (TVD).

Culprit and involved vessels were categorized as LAD, LCx, RCA, LM and combinations thereof (e.g., LAD+LCx, LAD+RCA, LAD+LCx+RCA, LCx+RCA, LM+TVD). Intravascular imaging (IVUS/OCT) was not routinely performed; therefore, plaque erosion versus rupture could not be adjudicated.

Outcomes

In-hospital complications (heart failure, arrhythmias, cardiogenic shock, need for urgent CABG) and mortality were documented when present. Systematic 30-day follow-up for mortality and major adverse cardiac events was not conducted and represents a major limitation.

Statistical analysis

Data were entered in Microsoft Excel and analyzed using SPSS-20. Categorical variables were expressed as frequencies and percentages, continuous variables as mean±SD. Group comparisons used chi-square tests for categorical variables and independent-sample t-tests for continuous variables; $p<0.05$ was considered statistically significant. The study was powered based on repolarization indices (Tpeak-Tend), with power 80%, α 5%, sample size 150, derived from Haarmark et al. No prespecified multivariate logistic regression model was applied; multivariate analysis of combined clinical and biomarker predictors of young-onset STEMI was not performed.

Results

Baseline characteristics

Among 150 acute STEMI patients, 33 (22%) were <40 years and 117 (78%) were ≥40 years. Mean age for the entire cohort was 52.74±12.58 years; younger and older groups had mean ages of 36.06±3.09 and 57.44±9.96 years, respectively. Males constituted 73.3% of the overall cohort, with a higher male predominance in the younger group (87.8% vs 69.2%). Breathlessness (72%) and palpitations (88%) were frequent presenting symptoms; younger patients more often reported chest pain, whereas older patients more often presented with breathlessness (p=0.01).

Table 1: Baseline demographic and clinical characteristics.

Characteristic	<40 years (n=33)	≥40 years (n=117)
Age, years (mean ± SD)	36.06 ± 3.09	57.44 ± 9.96
Male sex, n (%)	29 (87.8)	81 (69.2)
Chest pain, n (%)	24 (72.7)	81 (69.2)
Breathlessness, n (%)	21(63.6)	87 (74.3)
Syncope, n (%)	6 (18.2)	36 (30.7)
Palpitations, n (%)	28 (84.8)	104(88.9)

Table 2: Conventional risk factors in younger and older STEMI patients.

Risk factor	<40 years (n=33) n (%)	≥40 years (n=117) n (%)
Overweight	22 (66.6)	54 (46.15)
Obesity	7 (21.21)	31(26.5)
Hypertension	8 (24.24)	76 (64.96)
Diabetes mellitus	18 (54.5)	63 (53.8)
Smoking	20 (60.61)	66 (56.4)
Alcohol intake	17 (51.52)	62 (53.0)
Family history of premature CAD	12 (36.3)	29 (24.8)

Conventional risk-factor profile

Overweight (BMI 25–29.9 kg/m²) was observed in 50.7% overall, more frequent in the younger group (66.6%) than in the older group (46.15%); obesity was more common in older patients (26.5%).[1]

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Hypertension was present in 24.24% of younger versus 64.96% of older patients. Diabetes mellitus affected ~54% in both age groups. Smoking was highly prevalent (60.61% in younger vs 56.4% in older), and regular alcohol use occurred in ~53% of the cohort. Family history of premature CAD was more common in younger patients (36.3% vs 24.8%).[1]

Baseline investigations and novel risk markers

Mean fasting blood sugar and HbA1c were similar across age strata. Hemoglobin, leukocyte count, ESR, creatinine, urea and potassium did not differ significantly between groups. Lipid profiles showed elevated triglycerides and modest HDL in both groups—a TG-rich, HDL-lower pattern consistent with Indian ACS data. Mean triglycerides were 215.01±120.24 mg/dL in younger and 200.68±105.15 mg/dL in older patients; HDL was ~54 mg/dL in both.

LDL levels were comparable

Lipoprotein(a) levels >30 mg/dL were present in 75.76% of younger and 58.12% of older patients; mean Lp(a) was significantly higher in younger patients (37.36±9.19 vs 30.60±6.43 mg/dL; p<0.001). Homocysteine was elevated in both groups (~17 µmol/L) without significant age-related difference. hsCRP was elevated above normal in 51.52% of younger and 72% of older patients; mean hsCRP was 4.15±2.68 mg/L in younger versus 26.08±5.99 mg/L in older patients (p<0.0001).

Table 3: Baseline laboratory parameters and novel risk markers.

Parameter	<40 years (n=33) Mean ± SD	≥40 years (n=117) Mean ± SD	P value
Fasting blood sugar (mg/dL	135.30 ± 32.38	136.82 ± 35.56	0.84
HbA1c (%)	6.99 ± 2.16	7.01 ± 1.33	0.94
Total leukocyte count (10^3/µL)	12.22 ± 1.54	12.57 ± 1.44	0.22
Hemoglobin (g/dL)	14.03 ± 0.63	13.91 ± 0.89	0.47
ESR (mm/hr)	14.48 ± 7.66	16.12 ± 9.31	0.35
Serum creatinine (mg/dL)	0.97 ± 0.17	0.94 ± 0.15	0.32
Blood urea (mg/dL)	26.54 ± 8.97	24.22 ± 9.39	0.2
Serum potassium (mEq/L)	4.26 ± 0.84	4.52 ± 0.86	0.12
LDL cholesterol (mg/dL)	109.93 ± 25.01	106.49 ± 24.37	0.47
HDL cholesterol (mg/dL)	53.72 ± 10.76	54.56 ± 11.39	0.7
Triglycerides (mg/dL)	215.01 ± 120.24	200.68 ± 105.15	0.51
Lipoprotein(a)(mg/dL)	37.36 ± 9.19	30.60 ± 6.43	<0.001
Homocysteine (µmol/L)	17.50 ± 5.59	16.88 ± 5.32	0.55
hsCRP (mg/L)	4.15 ± 2.68	26.08 ± 5.99	<0.0001

Echocardiographic findings

Mean LVEF was moderately reduced in both groups: 41.51±5.65% in younger and 43.72±6.48% in older patients (p=0.07). Moderate LV dysfunction was more frequent in the younger group (69%) than older (54.3%), whereas mild dysfunction was relatively more common in older patients.

Table 4: Left ventricular ejection fraction categories by age group.

EF (%) category	<40 years (n=33) n (%)	≥40 years (n=117) n (%)
30–44 (moderate)	23 (69.0)	64 (54.3)
45–54 (mild)	8 (24.1)	45 (38.3)
≥55 (normal)	2 (6.9)	8 (7.4)

ECG and angiographic profile

Anterior wall MI was the most common ECG pattern (63.3% overall), occurring in 72.7% of younger and 60.7% of older patients. Inferior wall MI accounted for ~30.7%, with RV and posterior wall MI less frequent.

Coronary angiography showed SVD as the predominant pattern (51.3% overall), observed in 54.5% of younger and 50.4% of older patients. DVD and TVD rates were similar between groups. LAD involvement either isolated or in combinations was most common overall, more frequent in younger patients (42.4% isolated LAD) than in older patients (23.9%). RCA involvement was more common in older patients (23.9% vs 9.1%). LM and complex multivessel patterns (LM+TVD) were largely restricted to the older group.

Table 5: Extent of coronary artery disease by age group.

CAD extent	<40 years (n=33) n (%)	≥40 years (n=117) n (%)
Single-vessel	18 (54.5)	59 (50.4)
Double-vessel	11 (33.3)	42 (35.9)
Triple-vessel	4 (12.1)	16 (13.7)

Table 6: Coronary vessel involvement patterns.

Lesion pattern	<40 years (n=33) n (%)	≥40 years (n=117) n (%)
LAD alone	14(42.4)	28 (23.9)
LAD + LCx	4 (12.1)	17 (14.5)
LAD + RCA	7 (21.2)	12 (10.3)
LAD + LCx + RCA	3 (9.1)	16 (13.7)
LCx alone	2 (6.1)	4 (3.4)
LCx + RCA	0 (0.0)	11 (9.4)
LM + LAD + LCx + RCA	0 (0.0)	1 (0.9)
RCA alone	3 (9.1)	28 (23.9)

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Reperfusion strategies and in-hospital outcomes

Thrombolysis was performed in 12.1% of younger and 8.5% of older patients. PCI was the dominant reperfusion strategy: overall PCI to LAD was performed in 50% of cases, more frequently in younger patients (60.6%) than older (47%). RCA PCI was more common in older patients (18.8%). CABG was undertaken in 3% of younger and 6.8% of older patients; purely medical management was more frequent in younger patients (9.1% vs 4.3%).

In-hospital mortality was low across both groups; detailed breakdown of death and major adverse cardiac events, as well as systematic 30-day mortality, was not available.

Discussion

This prospective study of 150 acute STEMI patients from a South Indian tertiary center demonstrates that nearly one-quarter of events occur in patients younger than 40 years and that these young patients have a distinct clustering of conventional and novel risk factors, as well as a characteristic coronary anatomy.

Younger STEMI patients were predominantly male, overweight, and more likely to smoke and have a family history of premature CAD, consistent with prior Indian and international observations. Hypertension, by contrast, was concentrated in older patients, reflecting cumulative vascular risk with age. Diabetes mellitus was highly prevalent in both age strata, underlining the pervasive burden of cardiometabolic risk in this population.

Lipid profiles in both age groups showed a TG-rich, HDL-lower pattern, which accords with contemporary data from Indian ACS cohorts emphasizing high triglycerides and modest HDL as a hallmark of South Asian dyslipidemia. Elevated lipoprotein(a) was significantly more common and higher in younger patients, whereas hsCRP—a marker of systemic inflammation—was strikingly elevated in older patients. Together, these findings support a model in which younger STEMI reflects premature, genetically and metabolically driven atherothrombosis superimposed on lifestyle risks, while older STEMI reflects chronic inflammatory and metabolic burden leading to more diffuse disease. Angiographically, younger patients predominantly exhibited single-vessel LAD disease with anterior wall infarction, whereas older patients more frequently had multivessel involvement with RCA predominance. This pattern is concordant with prior Indian series and suggests that younger patients often harbor focal, high-risk plaques in the LAD territory, while older patients accumulate more extensive, multi-territory atherosclerosis (22-27). Because intravascular imaging was not performed, plaque erosion versus rupture could not be distinguished, and the study cannot address the important contemporary question of plaque phenotype in young STEMI.

From a quality-of-care perspective, PCI was the dominant reperfusion strategy, consistent with global guidelines favoring timely primary or pharmacoinvasive PCI in STEMI. However, detailed time metrics (first medical contact-to-device, door-to-needle, door-to-balloon), which are central to contemporary STEMI benchmarking, were not systematically captured and were therefore not analyzable. This gap limits comparison with global STEMI registries and underscores the need for standardized recording of ischemic times in future Indian studies.

Although we provide comprehensive univariate comparisons across clinical, biochemical and angiographic variables, multivariable models incorporating hemoglobin, leukocyte count, lipid fractions, smoking status and novel markers were not constructed; as a result, independent predictors of young-onset STEMI and of adverse outcomes could not be identified. Given sample size and single-center design, such modeling should ideally be undertaken in larger, multicenter cohorts.

Our findings align with and extend the South Asian component of the INTERHEART study (21), which showed earlier occurrence of AMI in South Asians largely explained by higher levels of conventional risk factors. The present study adds detailed Lp(a), homocysteine and hsCRP data, reinforcing the need to incorporate these markers into risk assessment in selected patients.

Limitations

Major limitations include:

- Single-center, modest sample size, limiting generalizability and statistical power for multivariate analyses.
- Lack of intravascular imaging (IVUS/OCT), precluding characterization of plaque erosion vs rupture, and inability to link angiographic appearance to underlying plaque biology.
- Absence of standardized recording and analysis of ischemic time metrics (first medical contact-to-device, door-to-needle, door-to-balloon), which are central to contemporary STEMI care benchmarking.
- No protocolized 30-day follow-up; mortality and major adverse cardiac events beyond hospitalization were not systematically captured.
- Multivariable regression incorporating clinical, hematologic, lipid and novel risk markers was not performed.

Despite these limitations, the study provides granular, age-stratified data on conventional and emerging risk factors and coronary anatomy in South Indian STEMI patients and highlights actionable targets for prevention and secondary care.

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Conclusions

In this South Indian cohort, young STEMI patients (<40 years) demonstrated a distinct risk-factor profile characterized by overweight, smoking, family history of premature CAD, elevated lipoprotein(a), and TG-rich dyslipidemia with predominantly single-vessel LAD disease and anterior wall infarction. Older patients (≥40 years) exhibited higher hsCRP, more hypertension, and more extensive multivessel coronary disease with RCA predominance. These age-stratified differences underscore the need for aggressive, early screening and modification of risk factors in young adults—especially smoking, adiposity and lipoprotein(a)—and comprehensive secondary prevention strategies across all age groups in South Asian populations. Future studies should incorporate intravascular imaging, standardized ischemic-time metrics, multivariable modeling and longer-term outcomes to further refine risk prediction and care pathways.

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