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Original Article

Clinical Characteristics and Short-Term Outcomes of Patients Presenting with Acute Myocardial Infarction having Multi-vessel disease - A Single Middle- eastern Tertiary-Care Center Experience

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ABSTRACT

Objective: Patients with multi-vessel coronary artery disease (MVD) compared to single-vessel coronary artery disease (CAD) have more comorbidities and poor in-hospital outcomes. We aim to analyze MVD-AMI patients regarding clinical data and short-term outcomes.

Methods: This is a retrospective analysis of the prospectively collected data registry, a single-center study reviewing the clinical details and hospital outcome measures of AMI patients referred to our center for early revascularization from 2016 to 2019.

Result: Out of 3041 patients presented with AMI, 491 (16%) had MVD on coronary angiogram. MVD-AMI patients were older, had a higher prevalence of DM, HTN, and prior history of ischemic heart disease compared to the non- MVD -AMI group ($p < 0.001$ for all). However, they presented more with non-anterior myocardial infarction, showed higher rates of post-myocardial infarction LV dysfunction, and mortality ($p < 0.001$). Older MVD-AMI patients showed higher rates of in-hospital morbidities and mortality compared to younger ones ($p < 0.001$). MVD- AMI women and Middle Eastern patients were older and showed a higher prevalence of cardiovascular risk factors compared to MVD-AMI men and South Asian patient population respectively. There were no significant differences recorded among the different subgroups of MVD-AMI patients regarding the hospital outcome measures.

Conclusion: Our study highlighted the clinical characters and poor outcomes of a high-risk group of MVD-AMI with different demographic backgrounds. Although age was a strong predictor for in-hospital poor outcomes, neither gender nor ethnicity affected the outcomes in them.

1. Introduction

Rupture of an atherosclerotic plaque and thrombotic occlusion of a coronary artery is the most common cause of acute myocardial infarction (AMI). The treatment of these AMI patients is usually a combination of medical therapy and revascularization with percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG).[1&2]

It is estimated that 40% of patients who present with STEMI (ST-elevation myocardial infarction) have a multi-vessel disease at index angiography.[3&4] Patients with multi-vessel coronary artery disease (MVD) compared to single-vessel coronary artery disease (CAD) have more comorbidities, cardiovascular risks, higher prevalence of left ventricular dysfunction and hence poor in-hospital outcomes.[5]

The current study aims to describe and analyze MVD-AMI patients regarding clinical data and short-term outcomes in a tertiary care center with the advantage of variable clinical backgrounds of its admitted patients. Treatment modalities and revascularization strategies selected for multi-vessel coronary artery disease patients were not the primary objectives of the current study.

2. Method

Our center STEMI registry is an observational single-center prospective registry of hospitalized patients with acute myocardial infarction, comprising patients initially hospitalized with

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identified symptoms of myocardial ischemia, electrocardiogram (ECG) findings, and elevated troponin levels.[6] A total of 3041 patients with AMI who were admitted to our cardiac center and underwent coronary angiography from 2016 to 2019 were enrolled in our study. All patients presented directly or were referred to our institution, a tertiary hospital with 24-h/7-day acute interventional facilities.

Our study had received approval from the ethics committee/institutional review board of our center.

We retrospectively reviewed and analyzed all clinical and cardiac imaging data:

2.1. Clinical data

Clinical data included baseline demographic data (age, gender, nationality, BMI& residential status (residence/hajj) and risk factors (diabetes mellitus (DM), hypertension (HTN), Smoking, dyslipidemia, cerebrovascular accidents (CVA), and history of ischemic heart disease or revascularization) for all patients. Clinical presentation (location of AMI) and laboratory results were also detected. The hospital outcome measures (in-hospital death, length of stay (LOS), left ventricular ejection fraction (LVEF),[7] pulmonary edema, cardiac arrest, cardiogenic shock, history of mechanical ventilation (MV), and history of left ventricular thrombus (LVT) for each patient all were detected and recorded.

2.2. Cardiac imaging data

All patients underwent a baseline transthoracic Doppler echocardiography within 24–48 h h of hospitalization. Left ventricular function including left ventricular ejection fraction (LVEF) & diastolic function and Mitral regurgitation (MR) was an integral part of the evaluation and is invariably included as a part of echocardiography data. Coronary angiography procedure and findings (access site (femoral/radial), left main (LM) disease, multi-vessel CAD (coronary artery disease), thrombus aspiration & glycoprotein IIb/IIIa inhibitors use) were also collected. We defined multi-vessel coronary artery disease by the presence of $\geq$50% diameter stenosis of two or more epicardial coronary arteries (proximal artery involvement or major branches have a jeopardy score of $\geq$1.5 with the equivalent myocardial weight of 10% or more) on the coronary angiogram.[8]

Also, we compared the clinical characteristics and hospital outcomes between MVD and non- MVD patients presented with AMI to identify the features and specific disease patterns in those high-risk groups of patients with a referral to the characteristics of subgroups of MVD- AMI patients.

2.3. Statistical analysis

The collected data were tabulated and analyzed using SPSS version 21.0. Categorical data were presented as numbers and

Table 1
Clinical and hospital outcome data of Multi-vessel AMI and non- Multi-vessel AMI patients.

Variable	Multi-vessel AMI N = 491 (16%)	Non- Multi-vessel AMI N = 2550 (84%)	*P*-value
Age (years)	59.03 ± 10.8	55.57 ± 11.9	<0.001
Male gender	403 (84%)	2147 (84%)	NS
South Asian	162 (33%)	739 (29%)	NS
Pilgrims	196 (40%)	790 (31%)	<0.001
BMI (kg/m^2)	27.22 ± 4.8	27.93 ± 5.2	0.06
HBA1-C (mmol/mol)	8.02 ± 2.3	7.56 ± 2.8	0.02
Admission HB level (g/dL)	13.28 ± 2.1	13.93 ± 2.0	<0.001
Troponin (ng/mL)	66.27 ± 152.4	97.73 ± 267.6	0.015
Serum Creatinine (mg/dL)	1.33 ± 1.6	1.25 ± 3.4	NS
DM	324 (66%)	1326 (52%)	<0.001
Smoking	128 (26%)	867 (34%)	<0.001
Obesity (BMI > 30 kg/m^2)	117 (24%)	765 (30%)	0.02
HTN	333 (68%)	1300 (51%)	<0.001
DLP	83 (17%)	357 (14%)	NS
CVA	14 (3%)	76 (3%)	NS
IHD	132 (27%)	484 (19%)	<0.001
OLD PCI/CABG	44 (9%)	178 (7%)	NS
STEMI type Anterior	230 (47%)	1453 (57%)	<0.001
H/O thrombolytic therapy	108 (22%)	459 (18%)	0.07
Glycoprotein IIb/IIIa inhibitors	78 (16%)	663 (26%)	<0.001
Thrombus aspiration	39 (8%)	331 (13%)	0.001
Post AMI LVEF%	38.59 ± 11.7%	41.30 ± 10.6%	<0.001
Grade II/III diastolic dysfunction	122 (25%)	331 (13%)	NS
Mitral regurgitation grade III/IV	35 (7%)	153 (6%)	NS
DBT < 90 min for PPCI	196 (40%)	1147 (45%)	NS
LM disease	49 (10%)	25 (1%)	<0.001
PPCI	314 (64%)	1785 (70%)	0.02
Sever LVD (LVEF < 30%)	128 (26%)	535 (21%)	<0.001
LOS (days)	7.49 ± 8.01	5.32 ± 7.85	<0.001
MV	51 (10%)	105 (4%)	<0.001
Pulmonary edema	40 (8%)	75 (3%)	<0.001
Cardiogenic Shock	39 (8%)	102 (4%)	<0.001
Cardiac arrest	48 (10%)	119 (5%)	<0.001
In- hospital mortality	29 (6)	63 (2.5%)	<0.001
Major bleeding (HB drop > 3 gm)	45 (9%)	115 (5%)	<0.001

AMI: Acute Myocardial Infarction; BMI: Body Mass Index; CABG: Coronary Artery Bypass Grafting; CVA: Cerebrovascular Accidents; DBT: Door to Balloon Time; DLP: Dyslipidemia; DM; Diabetes Mellitus; HB: Hemoglobin; HBA1C: Glycosylated hemoglobin; IHD: Ischemic Heart Disease; LM: Left Main; LOS: Length Of Stay; LVD: Left Ventricular Dysfunction; LVEF: Left Ventricular Ejection Fraction; MV: Mechanical Ventilation; PCI: Percutaneous Coronary Intervention; PPCI: Primary Percutaneous Coronary Intervention.

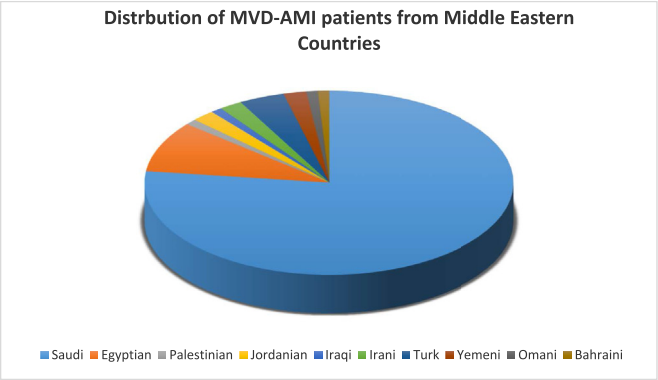
percentages while quantitative data were expressed as mean ± standard deviation using chi-squared and *t*-tests respectively. Binary regression analysis was also performed. The accepted level of significance in our analysis was stated at 0.05 ($p < 0.05$ was considered significant).

3. Results

We categorized our data into two main categories: patient's clinical characteristics and hospital outcome measures and compared between Multi-vessel CAD- AMI patients (Group I; 491 (16%)) and non- Multi-vessel CAD- AMI patients (Group II; 2550 (84%)) regarding those data. Also, we discussed some subgroups' characteristics.

MVD- AMI patients were significantly older at age, had a significantly higher prevalence of DM, HTN, and history of ischemic heart disease but a lower prevalence of smoking and obesity compared to Non-multi-vessel CAD group. They presented mainly with non-anterior STEMI and were less indicated to use the intensive anti-ischemic treatment (thrombus aspiration, glycoprotein IIb/IIIa inhibitors, and primary percutaneous coronary intervention (PPCI)) compared to the other group of patients. Moreover, they showed higher rates of post-myocardial infarction left ventricular dysfunction, complications, and mortality. Table 1.

Two hundred and fifty-one MVD-AMI patients (51%) were old (age> 60 years old) and they were fewer smokers compared to young. They also showed higher rates of in-hospital morbidities and mortality compared to young. Table 2 Majority (82%) of MVD-AMI patients were men. Compared to men, MVD- AMI women were older at age and they showed higher rates of cardiovascular risk factors. However, MVD-men showed higher rates of smoking and left ventricular dysfunction compared to women. Only 33% of our MVD-AMI were from South Asian countries; however, 67% were Middle Eastern population. Distributions of MVD- AMI patients from Middle Eastern and South Asian countries were shown in Figs. 1 and 2. Middle Eastern MVD- AMI patients were older and showed higher rates of cardiovascular risk factors compared to the South Asian population. Otherwise, regarding the type of AMI presentation, intensive anti-ischemic treatment, and hospital outcome measures, there was no significant difference recorded between both genders and ethnic groups. Table 3.



AMI: Acute Myocardial Infarction; MVD: Multi- Vessel Disease

Fig. 1. Distribution of MVD- AMI patients from Middle Eastern countries.

Being elderly, presentation with anterior STEMI, severe left ventricular systolic dysfunction (LVEF<30%), and post AMI cardiogenic shock are the independent predictors of mortality among our population. Table 4.

4. Discussion

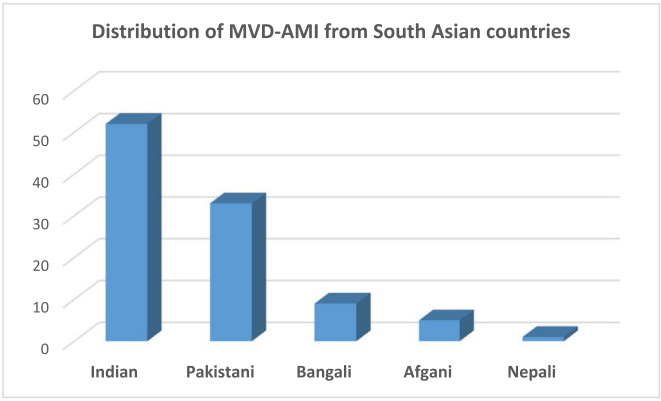
Most of the studies highlighted the treatment modalities, revascularization strategies selected for multi-vessel coronary artery disease patients and evaluated the adherence to guidelines according to anatomical and clinical criteria[9–13] however, this is not our aim in the current study. Our study provides beneficial insights into the clinical characters and outcomes of a special high-risk group of patients presenting with AMI.

The present study was derived from our center-AMI registry and it provided several important clinical findings. First, we have shown that only 16% of our AMI had MVD and 64% of them were treated

Table 2
Comparing clinical and hospital outcome data of Multi-vessel AMI between young and old patients.

Variable	Multi-vessel AMI- Young (age<60y) N = 240 (49%)	Multi-vessel AMI- Old (age>60 y) N = 251 (51%)	*P* value
Male gender	206 (86%)	197 (79%)	0.05
Pilgrims	79 (33%)	117 (47%)	0.001
HBA1-C (mmol/mol)	7.94 ± 2.1	8.10 ± 2.4	NS
DM	159 (66%)	165 (65%)	NS
Smoking	82 (34%)	46 (18%)	<0.001
Obesity (BMI > 30 kg/m^2)	57 (24%)	60 (24%)	NS
HTN	163 (68%)	170 (68%)	NS
DLP	45 (19%)	38 (15%)	NS
IHD	61 (25%)	71 (28%)	NS
OLD PCI/CABG	18 (7%)	26 (10%)	NS
STEMI type Anterior	117 (49%)	113 (45%)	NS
Thrombolytic therapy	57 (24%)	51 (20%)	NS
Glycoprotein IIb/IIIa inhibitors	41 (17%)	37 (15%)	NS
Thrombus aspiration	18 (7%)	21 (8%)	NS
LM	21 (9%)	28 (11%)	NS
LVEF%	37.81 ± 12.1%	39.40 ± 11.3%	NS
Grade II/III diastolic dysfunction	26 (11%)	58 (23%)	NS
Mitral regurgitation grade III/IV	17 (7%)	23 (9%)	NS
Pulmonary edema	7 (3%)	33 (13%)	<0.001
Cardiogenic shock	13 (5%)	26 (10%)	<0.001
Mechanical ventilation	15 (6%)	36 (14%)	<0.001
Cardiac arrest	20 (8%)	28 (11%)	NS

AMI: Acute Myocardial Infarction; BMI: Body Mass Index; CABG: Coronary Artery Bypass Grafting; DLP: Dyslipidemia; DM; Diabetes Mellitus; HBA1C: Glycosylated hemoglobin; IHD: Ischemic Heart Disease; LM: Left Main; LOS: Length Of Stay; LVEF: Left Ventricular Ejection Fraction; PCI: Percutaneous Coronary Intervention.



AMI: Acute Myocardial Infarction; MVD: Multi- Vessel Disease

Fig. 2. Distribution of MVD- AMI patients from South Asian countries.

Table 4
Binary regression analysis for prediction of mortality.

Variable	B	S.E.	EXP(B)	*P*-value
Age	0.046	0.019	1.047	0.013
Anterior STEMI	0.899	0.455	0.407	0.048
LVEF < 30%	1.719	0.435	0.179	<0.0001
Cardiogenic shock	0.987	0.456	0.187	0.012

LVEF: Left Ventricular Ejection Fraction; STEMI: ST-Elevation Myocardial Infarction.

with PPCI. Second, those MVD-AMI patients had special clinical characters as they had multiple cardiovascular risk factors, less evidence of myocardial injury (presented mainly with non-anterior AMI and showed a lower peak of troponin), low thrombus burden (lesser rate of thrombus aspiration on coronary angiogram) and poor hospital outcomes. Third, an older patient with MVD presented with AMI had poor in-hospital outcomes compared to young. Fourth, there were no gender or ethnic differences

Table 3
Comparing clinical and hospital outcome data of Multi-vessel AMI between both genders and ethnic groups.

Variable	Multi-vessel AMI- Males N = 403 (82%)	Multi-vessel AMI- Females N = 88 (18%)	*P* value
Age (years)	58.25 ± 10.5	63.11 ± 11.2	<0.001
Pilgrims	160 (40%)	36 (41%)	NS
BMI (kg/m^2)	27.0 ± 4.6	28.38 ± 5.5	0.02
HBA1-C (mmol/mol)	7.92 ± 2.3	8.52 ± 2.4	0.05
DM	262 (65%)	62 (70%)	NS
Smoking	125 (31%)	3 (3%)	<0.001
Obesity (BMI > 30 kg/m^2)	91 (23%)	26 (30%)	NS
HTN	265 (66%)	68 (77%)	0.08
DLP	64 (16%)	19 (22%)	NS
IHD	110 (27%)	22 (25%)	NS
OLD PCI/CABG	40 (10%)	4 (5%)	NS
STEMI type Anterior	194 (48%)	36 (41%)	NS
Thrombolytic therapy	88 (22%)	20 (23%)	NS
Glycoprotein IIb/IIIa inhibitors	70 (17%)	8 (10%)	0.08
Thrombus aspiration	32 (8%)	7 (8%)	NS
LM	43 (11%)	6 (7%)	NS
LVEF%	38.09 ± 12.3%	41.25 ± 9.7%	0.01
Grade II/III diastolic dysfunction	96 (24%)	17 (19%)	NS
Mitral regurgitation grade III/IV	36 (9%)	7 (8%)	NS
Pulmonary edema	32 (8%)	8 (9%)	NS
Cardiogenic shock	36 (9%)	3 (3%)	0.09
Mechanical ventilation	44 (11%)	7 (8%)	NS
Cardiac arrest	42 (10%)	6 (7%)	NS
	Multivessel AMI-South Asian N = 162 (33%)	**Multi-vessel AMI- Middle Eastern N = 329 (67%)**	
Age (years)	57.66 ± 10.1	59.65 ± 11.1	0.05
Pilgrims	99 (61%)	97 (29%)	<0.001
DM	97 (60%)	227 (69%)	NS
Smoking	34 (21%)	94 (28%)	NS
Obesity (BMI > 30 kg/m2)	30 (19%)	26 (28%)	0.05
HTN	98 (60%)	235 (71%)	0.08
DLP	29 (18%)	54 (16%)	NS
HD	41 (25%)	91 (28%)	NS
OLD PCI/CABG	13 (8%)	31 (9%)	NS
STEMI type Anterior	74 (46%)	156 (47%)	NS
Thrombolytic therapy	37 (23%)	71 (22%)	NS
Glycoprotein IIb/IIIa inhibitors	29 (18%)	49 (15%)	NS
Thrombus aspiration	8 (5%)	31 (9%)	NS
LM	16 (10%)	33 (10%)	NS
LVEF%	38.47 ± 10.1%	38.82 ± 11.3%	NS
Mitral regurgitation grade III/IV	12 (7%)	30 (9%)	NS
In-hospital death	10 (6%)	19 (6%)	NS
Pulmonary edema	13 (8%)	27 (8%)	NS
Cardiogenic shock	17 (10%)	22 (7%)	NS
Mechanical ventilation	18 (11%)	33 (10%)	NS
Cardiac arrest	19 (12%)	29 (9%)	NS

AMI: Acute Myocardial Infarction; BMI: Body Mass Index; CABG: Coronary Artery Bypass Grafting; DLP: Dyslipidemia; DM; Diabetes Mellitus; HBA1C: Glycosylated hemoglobin; IHD: Ischemic Heart Disease; LM: Left Main; LOS: Length Of Stay; LVEF: Left Ventricular Ejection Fraction; PCI: Percutaneous Coronary Intervention.

regarding post-myocardial infarction complications or mortality and this might reflect equal service provided to them.

4.1. Clinical characters

Multi-vessel coronary artery disease (CAD) is found in up to 16% of the patients presenting with AMI and this is lesser than reported by some other studies.[14&15] This could be explained by the fact that the population of our study was from different countries and places with variable underlying background, racial, genetics, and atherosclerosis nature. It is shown that MVD patients were older and had a higher prevalence of cardiovascular risk factors (DM and HTN) and this is similar to other studies.[16] They also showed lower rates of smoking& obesity compared to the other group and these were observed by other studies.[17&18] They presented mainly with non-anterior myocardial infarction and lower peak troponin values. This is could be explained also by many factors related to our diverse populations including genetic variation, degree of atherosclerosis, different thrombotic activity, and distribution of collateral circulation.

Regarding coronary revascularization, the goal for minimally invasive approaches has led to a wider application of PCI, despite its association with more re-interventions. The utilization rate of PCI among those patients with MVD-AMI was appropriate and close to what was recorded by some recent studies.[9&19] Moreover, MVD-AMI had a higher prevalence of left main disease and hence poor in-hospital outcomes and mortality and this is proven by many other studies.[20–22] These worse outcomes could be explained by being elderly, having multiple morbidities, and significant left ventricular dysfunction post-AMI.

4.2. Subgroups

Aging is associated with cellular oxidative stress, inflammation, and shifts in gene expression that contribute to increased vascular stiffness, endothelial dysfunction, and thrombogenicity. It is also known to be associated with hypercoagulability, hyper-fibrinolysis, and thrombus instability.[23&24] It was found that elderly MVD presented with AMI had multiple morbidities and were at high-risk in terms of mortality and adverse events even after revascularization and that's similar to what was concluded by the previous studies.[25&26]

On the other hand, MVD- Women were older at age. The protective hormonal milieu in reproductive years (15–45 years), underreporting of symptoms, atypical features of chest pain, presence of diffuse coronary vascular disease, and lesser accessibility to better health facilities all might explain their presentation at an older age compared to men. They also had higher rates of cardiovascular risk and more preserved LVEF post-AMI compared to men. Interestingly, they had similar in-hospital outcomes to men and this is close to what was reported by other authors.[27&28]

Also, we found that South Asian patients had less prevalent cardiovascular risk factors with no difference in the short-term mortality after AMI among them compared with Middle Eastern patients and that's was mentioned by previous studies.[29–31] This ethnic and racial AMI cardiovascular risk factors variation could be explained by different genetic, cultural, and environmental factors which might lead to the difference in the degree of atherosclerosis, thrombotic activity, and distribution of collateral circulation. Despite the difference in cardiovascular risk profile, there were similar hospital outcomes in both groups and this might reflect the proper equal health care service and management provided by our center to those variant high-risk patients with no gender or ethnic bias.

Finally, the number of enrolled patients is limited due to the nature of single-center study and selection of AMI patients only. Moreover, no follow-up data or long-term outcomes and that is because we are a tertiary center and refer most cases back to their primary hospitals after a certain follow-up period of revascularization. Moreover, a significant number of our population were pilgrims; they were going back to their countries after doing hajj, and hence no follow-up was available. Further studies are necessary for the future to create a multicenter-larger sample study with organized follow-up data.

In conclusion, there are remarkable variations in baseline demographics, clinical characteristics, and hospital outcomes between MVD and non-MVD-AMI patients. Although AMI-MVD presented mainly with non-anterior myocardial infarction and had less evidence of myocardial injury, they showed higher rates of post-myocardial infarction complication and poor hospital outcomes. Age was determined as a strong predictor for more complications and poor outcomes however, neither gender nor ethnicity emerge as a significant effect on the outcome among MVD-AMI patients. Being elderly, presentation with anterior STEMI, severe left ventricular systolic dysfunction (LVEF<30%), and post AMI cardiogenic shock are the independent predictors of mortality among our population. Because of the poor outcome of that high-risk group of AMI, more attention and special hospital care are highly needed with a proper treatment plan. All those findings are considered valuable as no more studies discussed the clinical background of that high-risk AMI group in the Middle Eastern region.

5. Key message

MVD patients who presented with AMI are at high risk for post−MI complications, adverse events and we should pay more attention to that high-risk group of patients to improve their hospital outcomes.

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Declaration of competing interest

None.

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