Section: Cardiology

Original Research Article

THE INFLUENCE OF MULTIVESSEL DISEASE ON MYOCARDIAL REPERFUSION AND SUBSEQUENT SURVIVAL IN ST-ELEVATION MYOCARDIAL INFARCTION

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Abstract

Background: Multi-vessel disease is associated with higher mortality rates, higher occurrence of recurrent ischaemic events and adverse prognosis in STEMI patients, which may further alter clinical course and decision making. To evaluate the impact of multivessel disease on in-hospital and long-term outcomes in STEMI patients undergoing percutaneous coronary intervention and compare these outcomes in patients with single vessel disease. **Materials and Methods:** This study includes 474 consecutive patients with acute STEMI who underwent percutaneous coronary intervention. Invasive coronary angiography was done as a part of primary PCI and in indicated patients, after informed consent. Patients were followed up till discharge and then at 1 month and 3 months. Data were entered in Microsoft Excel and analysed using IBM SPSS software. **Result:** Myocardial reperfusion was assessed by ST-segment recovery and TIMI flow. Patients with multivessel disease had significantly more incomplete ST-segment resolution as compared to single vessel disease (34.11% vs 8.45%, $p < 0.01$). In-hospital heart failure occurred significantly higher in patients with multivessel disease (22.7%) as compared to patients with single vessel disease (12.7%) (p=0.027). In hospital MACE occurred significantly higher in MVD than SVD (28.69% vs 14.08%, $p = 0.009$). 3-months MACE occurred significantly higher in MVD than SVD (1.47% vs 17.5%, $p = 0.001$). **Conclusion:** Patients with multivessel disease have significantly highly occurrence of incomplete ST resolution, heart failure and in hospital and 3 months MACE.

INTRODUCTION

Global burden of coronary artery disease (CAD) is increasing in all countries.[1] Primary percutaneous coronary intervention (PCI) in acute myocardial infarction (AMI) results in greater patency of the infarct-related artery (IRA) and lower the rates of death, re-infarction, and stroke as compared to fibrinolysis alone.[2] However in addition to culprit vessel approximately 50 to 60 % of the STEMI patients have multi-vessel CAD.[3,4] Increase in cardiovascular risk in patients with multi-vessel CAD is explained by extensive atherosclerotic disease, slow flow and impaired function of noninfarct zones, and presence of stunned and hibernating myocardium.[5,6] Multiple treatment strategies have been described, including multi-vessel percutaneous coronary intervention (PCI) at the time of the index procedure and staged PCI of non-culprit vessels.[7]

Objective

To evaluate the impact of multivessel disease on in-hospital and long-term outcomes in STEMI patients undergoing percutaneous coronary intervention (PCI) and compare these outcomes in patients with single vessel disease.

MATERIALS AND METHODS

After approval from Institutional Review Board and informed consent, patients with diagnosis of STEMI, admitted in Intensive Coronary Care Unit in GMCH Kottayam were included in study. Data was collected on predefined structural questionnaire. Multivessel disease was defined as the presence of stenosis of at least 50% in ≥2 major epicardial coronary arteries or their major branches, assessed

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by visual estimation during initial coronary angiography.

Inclusion Criteria

1. Patients with STEMI, defined by symptoms of ischemia, ST elevation in ECG.
2. Age group of ≥ 18 years
3. Primary PCI patients
4. Patients undergoing coronary angiography after thrombolysis within 1 month.

Exclusion Criteria

1. Myocarditis
2. Valvular / congenital heart disease
3. AMI associated with aortic dissection

ECG was taken at diagnosis and 90 minutes after reperfusion and echocardiography at admission. Invasive coronary angiography was done in patients as a part of primary PCI and in indicated patients who were thrombolized. Patients were followed up till discharge then at 1 month and 3 months. The ST-segment resolution was evaluated on a 12-lead electrocardiogram on admission and 1 h after PCI. The sum of ST-segment elevation was measured at the J point in leads I, aVL, and V1–V6 for anterior MI and leads II, III, aVF, V5, and V6 for nonanterior MI. The percentage resolution of ST-segment elevation between before and after PCI was categorized as complete (≥ 70%), partial (30 - 70%), or absent (< 30%).8,9 In the current study we analysed the occurrence of MACE including heart failure, non-fatal re-infarction, recurrent angina pain, re-hospitalization for cardiovascular-related illness, all-cause mortality.

All the data collected were coded and entered in Microsoft Excel sheet and analysed using SPSS statistical software version 22. Quantitative variables were summarised using mean and standard deviation (SD). Pearson Chi-square test and Fisher's exact test were used for comparing categorical variables between groups. A p value of <0.05 was considered significant.

Ethics: IRB Clearance Yes.

RESULTS

Total 474 patients were included in this study. Patients were stratified into two groups based on number of vessels involved. 34.8% (165) patients had single vessel disease (SVD), while 65.1% (309) were diagnosed with multi vessel disease (MVD). Out of 474 patients 56.3% (267) were male, mean age was 56.35 ± 10.07 years. Diabetes mellitus was present in 51.1% (242) patients, hypertension in 44.7% (212), smoking in 37.8% (179), and dyslipidaemia in 27.8% (132) patients and family history of CAD in 27.6% (131). Prior CAD in 9.1% (43). Patients with MVD were much older with significantly higher mean age, p-value of <0.001. All baseline characteristics of the patients are summarized in [Table 1].

Procedural characteristics are summarized in [Table 2]. Proportion of patients with baseline TIMI flow 0 or TIMI 1 flow, was significantly higher in MVD group as compared to SVD group ($p < 0.05$). Proportion of patients with high syntax score was significantly more in patients with MVD as compared to patients with SVD. (1.41% in SVD vs 42.64% in MVD, $p < 0.00001$). There was no significant difference in post procedural TIMI flow in two groups.

Patients with partial ST-segment resolution were significantly more in MVD group (30.23%) as compared to SVD group (5.63%), p<0.00001 [Figure 1]. Proportion of patients with complete ST-resolution (defined as >70% ST resolution), was significantly higher in patients with SVD as compared to MVD.

Out of 165 patients with SVD, 23(14.08%) developed in-hospital MACE and out of 309 patients with MVD, 89 (28.69%) developed in-hospital MACE. Multivessel disease was associated with occurrence of in-hospital major adverse cardiovascular events, consisting of heart failure, recurrent angina/ischemia, arrhythmia, cardiogenic shock and death (p=0.0198). 3 months occurrence of MACE was significantly higher in patients with MVD (17.5%) as compared to SVD (1.47%) (p=0.001) [Table 3].

Number of patients with free of in-hospital complications were significantly higher in SVD group (85.92%) as compared to MVD group (71.32%) (p=0.0198).

Table 1: Baseline Characteristics.

		Total (n=474)	SVD (n=165)	MVD (n=309)	p value
Age (years)	Mean ± SD	56.35 ± 10.07	52.99 ± 9.28	58.19 ± 10.05	<0.001
Gender	Male	267 (56.3%)	96 (58.2%)	171 (55.5%)	0.552
	Female	207 (43.7%)	69 (41.8%)	138 (44.7%)	
Comorbidity	Diabetes mellitus	242 (51.1%)	61 (37%)	181 (58.6%)	<0.001
	Hypertension	212 (44.7%)	53(32.1%)	159 (51.5%)	<0.001
	Dyslipidaemia	132 (27.8%)	37 (22.4%)	95 (30.7%)	0.054
	Smoking	179 (37.8%)	59(35.8%)	120(38.8%)	0.510
	Family history of CAD	131(27.6%)	38 (23%)	93 (30.1%)	0.101
	Prior CAD	43 (9.1%)	6 (3.6%)	37 (12%)	0.003
Presenting symptoms	Angina	458 (96.6%)	161 (97.6%)	297 (96.1%)	0.402
	Breathlessness	108 (22.8%)	33 (20%)	75 (24.3%)	0.291
	Resuscitated cardiac arrest	26 (5.5%)	10 (6.1%)	16 (5.2%)	0.688
Ejection fraction (EF)	Mean EF (%) ± SD		47.3% ± 8.5	46.4% ± 10.2	0.319

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Angiographic characteristics and procedural results Culprit Vessel was LAD in 57.9% of SVD group and 49.2% of MVD group. Ostial LAD lesion was there in 17% of SVD and 27.5% of MVD group (0.010). Significant LMCA disease was present in 9.9% of total patients all in MVD group (<0.001). Significant difference in baseline TIMI flow noted among both groups. SYNTAX score (SX) was Low SX (<16) in 96 (59.15%) SVD compared to 76 (24.81%) MVD group< 0.00001. High SX (>22) in 2 (1.41%) of SVD compared to132 (42.64%) of MVD group <0.00001. No significant difference noted in post procedure TIMI flow.

Table 2: Angiographic characteristics and procedural results

		SVD (n=165)	MVD (n=309)	p value
Culprit Vessel	LAD	95 (57.9%)	152 (49.2%)	0.031
	LCX	12 (7.3%)	34 (11%)	
	RCA	55 (33.3%)	121 (39.2%)	
Ostial LAD	Total 113(23.8%)	28 (17%)	85 (27.5%)	0.010
LMCA	Total 47 (9.9%)	0	47 (15.2%)	<0.001
Baseline TIMI flow (%)	0	112 (67.9%)	252 (81.6%)	0.001
	1	48 (29.1%)	50 (16.2%)	
	2	2 (1.2%)	7 (2.3%)	
	3	3 (1.8%)	0 (3%)	
SYNTAX score (SX)	Low SX (<16)	96 (59.15%)	76 (24.81%)	< 0.00001
	Mid SX (16-22)	65 (39.44%)	101 (32.56%)	0.33
	High SX (>22)	2 (1.41%)	132 (42.64%)	<0.00001
Post procedural TIMI flow (%)	0	0	0	-
	1	0 (0%)	3 (1%)	0.219
	2	7 (4.2%)	7 (2.3%)	
	3	158 (95.8%)	299 (96.8%)	

Adverse events like atrial fibrillation, left ventricular failure and adverse kidney injury were higher among the MVD group with significant p value.

Table 3: Adverse Events.

Adverse Events		SVD (165)	MVD (309)	Total	p
		n	n	n	
In Hospital arrhythmia	AF	23	93	116	<0.001
	VT	2	6	8	0.557
PIA		2	8	10	0.320
LVF		21	70	91	0.009
AKI		2	20	22	0.010
Death		6	31	37	0.013
Others	Ischemic hepatitis	6	31	37	0.013
	LRTI	2	0	2	
30 DAY EVENTS	LVF	6	31	37	0.100
3 MONTHS EVENTS	ADHF	0	2	2	<0.001
	CAD ACS NSTEMI	0	2	2	
	CAD ACS Unstable angina	0	4	4	
	EA	0	28	28	
	LVF	0	10	10	

Table 4: Post procedure outcome by number of vessels involved

		SVD	MVD	p value
Duration of hospital stay (days)	Mean ± SD	3.99 ± 0.75	4.59 ± 1.3	0.0004
In-hospital complications	No complications	85.92%	71.32%	0.0198
	Acute kidney injury	1.41%	6.98%	0.084
	Heart failure	9.86%	22.48%	0.027
	Cardiogenic shock	2.82%	3.88%	0.697
	Death	4.23%	6.98%	0.435

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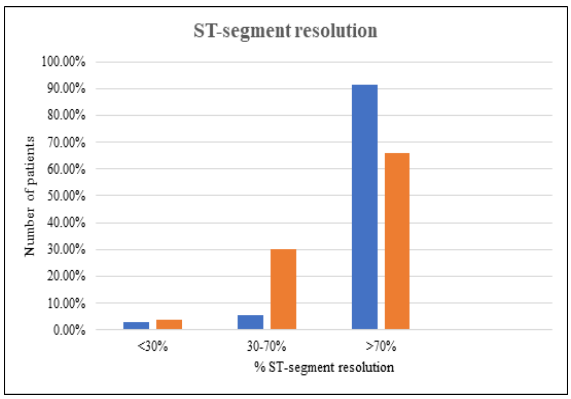

Figure 1: ST segment resolution

DISCUSSION

In our study multi-vessel coronary artery disease (MVD) is diagnosed in 65.1% (309) STEMI patients which coincides with the reported occurrence of 46–66% in past studies.[10,11] The mean age in patients with single vessel disease was 52.99 ± 9.28 years which was significantly lower as compared to patients with multivessel disease 58.19 ± 10.05 years. (P value = 0.0004). In previous studies also, patients with multivessel disease were older as compared to single vessel disease,[12,13] and have also shown that diabetes mellitus is closely associated with the presence of multivessel disease. In our study, 61 patients with diabetes mellitus had SVD and 181 patients with diabetes mellitus had MVD, (p <0.001). In our study, 53 patients with hypertension had SVD and 159 patients with hypertension had MVD (p <0.001) which is similar to study by Junhua Ge, et al,[14] Proportion of patients with high syntax score was significantly more in patients with MVD as compared to patients with SVD. (1.41% in SVD vs 42.64% in MVD, p < 0.00001). Mean syntax score in patients with SVD was 13.82 ± 5.22 and in patients with MVD it was 20.5 ± 6.62 (p<0.0001). Reduced reperfusion success may contribute to the adverse prognosis in patients with multivessel disease. In our study, post procedural TIMI-3 flow was present in 158 (95.77%) patients with SVD and 299 (96.89%) patients with MVD. There was no significant difference in postprocedural TIMI flow in two groups. Despite equivalent rates of epicardial TIMI-3 flow in patients with single and multivessel disease, myocardial reperfusion success as assessed by ST-segment resolution was impaired in patients with multivessel disease which was similar to previous study by Sorajja et al.[3] De Luca et al,[5] and Tarantini et al.[6] Differences in the time to treatment, open infarct-related artery and presence of collateral circulation compared to other studies might be an explanation. Reduced myocardial perfusion has been demonstrated to result in diminished survival, despite restoration of normal epicardial blood flow.[15] Whether remote CAD is a marker of more disseminated atherosclerosis with microcirculatory involvement in the infarct vessel that might directly diminish myocardial perfusion, reflects a greater amount of distal embolization with subsequent capillary plugging or indicates greater systemic inflammation is unknown, and deserves further study. Mean duration of hospital stay was significantly higher in patients with multivessel disease (3.99 ± 0.75 days in SVD vs 4.59 ± 1.3 days in MVD, with p value = 0.0004). In-hospital heart failure occurred significantly higher in patients with multivessel disease (22.48%) as compared to patients with single vessel disease (9.86%) (p=0.027). In our study cumulative incidence of in-hospital major adverse cardiovascular events (MACE), were significantly higher in patients with MVD (27.13%) as compared to SVD (14.08%), (p=0.035). Study conducted by de Waha et al reported 9.6% vs. 4.8% MACE with p-value = 0.01 in patients with MVD and SVD respectively.[13] Similarly, Jaski et al.,16 showed that patients with multivessel disease had higher incidence of overall complications (32% vs 13%) p < 0.02). 3-Months Major Adverse Cardiovascular Events (MACE) were significantly higher in patients with MVD (17.5%) as compared to SVD group (1.47%) (p=0.001). These findings were comparable to previous studies.[3,6] We could confirm that patients with STEMI and MVD are at high risk of adverse clinical outcomes, which is mainly due to recurrent ischemic events. The high rate of cardiovascular events following STEMI in patients with MVD is likely to be multifactorial and is a marker of more advanced CAD and diffuse atherosclerosis. These patients evidently need to be monitored closely and need aggressive treatment of traditional cardiovascular risk factors and recurrent ischemia testing following the acute event.

CONCLUSION

Multivessel disease is associated with reduced myocardial reperfusion success as measured by ST-segment resolution, prolonged hospitalization, higher incidence of in-hospital heart failure, higher cumulative incidence of in-hospital major adverse cardiovascular events as compared to single vessel disease and 3-month major adverse cardiovascular events especially effort angina.

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