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Original article

Complete Versus Culprit-Only Revascularization Strategies to Treat Multivessel Disease After Primary Percutaneous Coronary Intervention for ST Elevation Myocardial Infarction

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Abstract:

Background: Acute myocardial infarction with multivessel disease represents a higher cardiovascular risk and revascularization strategy in such patients remains a subject of conflict. The aim of our study was to assess the potential benefit of complete revascularization as compared to culprit vessel only revascularization in ST-segment elevation myocardial infarction (STEMI) patients who has multivessel disease (MVD). **Methods:** The current study is a single center prospective study conducted on 150 Patients presented with acute ST-segment elevation myocardial infarction to emergency department (ED) and cardiac care unit (CCU) in Nasr City Hospital, and according to revascularization strategy, patients were divided into two groups; Group I: patients received complete revascularization before hospital discharge and Group II: patients receiving culprit-only revascularization. **Results:** There was significant lower MACE in group I ($p<0.05$). The occurrence of non-ST segment acute coronary syndrome (NSTE-ACS) as well as the need for ischemia-driven revascularization- were significantly lower in the complete revascularization group ($p=0.028$ & $p=0.008$), respectively. **Conclusion:** in STEMI patients with multivessel disease, complete revascularization- as compared to culprit-only revascularization strategy- reduced MACE and improved short-term outcome.

Keywords: ST-segment Elevation Myocardial Infarction; Multivessel Disease; Primary Percutaneous Coronary Intervention.

Introduction

Acute myocardial infarction (AMI) has been reported to be the leading cause of death in patients hospitalized for cardiovascular disease in industrial countries [(1)]. Among the various treatment approaches, primary percutaneous coronary intervention (p-PCI) is considered as the treatment of choice for patients presenting with ST-segment elevation myocardial infarction (STEMI), when it can be performed expeditiously by an experienced team [(2)]. This strategy has been reported to be superior to thrombolytic therapy in improving morbidity and mortality. The goal of this treatment approach is the restoration of flow within 90 minutes of presentation to a PCI-equipped center [(3)]. The prevalence of multi-vessel disease (MVD) has been reported to be 40-65% in patients with AMI undergoing p-PCI [(4)]. This finding suggests that a significant proportion of these patients have an increased risk of death and adverse outcomes even after receiving reperfusion therapy through thrombolysis or p-PCI for infarct-related artery (IRA) [(5)].Recent technological and technical advancement in PCI techniques has broadened the treatment scope to now include patients with multivessel disease. Regardless of which modality is chosen, an inter-professional approach should be undertaken and account for various factors, including patient preference, surgical risk, and operator skill [(6)]. Treatment strategies vary widely from an aggressive approach, which treats all significant lesions in the acute phase of p-PCI, to a conservative approach with p-PCI of only the IRA and subsequent medical therapy unless recurrent ischemia occurs. However, the prognostic impact of revascularization for non-IRA in patients with MVD after p-PCI on clinical outcomes-has not been fully investigated [(7)]. Other treatment strategies include staged procedures in which the IRA is treated acutely and other lesions are treated later-during the hospital stay or within the first month following hospital discharge- [(8)].

Patients and Methods:

Type of study:

- Case control prospective study over 90-days duration follow-up.

Period of study:

- 2 years (from January 2019 to 2021).

Sample setting:

- ED and CCU in Nasr City Health Insurance Hospital.

Study design:

The study was plannedasa single center prospective study on150patients who presented to Nasr City Health Insurance Hospital with STEMI, in the period from January 2019 to June 2021 (excluding the short periods of primary percutaneous coronary intervention [pPCI] stalling due to Covid-19 pandemic).

Inclusion criteria:

A hundred and fifty patients with STEMI and multivessel disease- who were treated with pPCI- divided into two groups:

- Group I: 75 patients; complete revascularization group (intervention group).
- Group II: 75 patients; culprit-only revascularization group (control group).

Exclusion criteria:

Patients older than 90 years of age, patients with single vessel disease (no significant lesions beside the culprit vessel), patients planned for surgical revascularization, and patients with cardiogenic shock.

All patients were subjected to:

Informed consent

Baseline evaluation (review of medical history, clinical and physical examination, 12 lead electrocardiogram (ECG), laboratory investigations [glycated hemoglobin, peak creatinine level and low-density lipoprotein cholesterol levels], coronary angiography and pPCI).

Study endpoints:

Primary end point: composite endpointof90-dayscardiovasculardeathor myocardial infarction (MI).

Secondary endpoint: 90-days either one of; death from any cause, myocardial infarction, Non-ST segment elevation acute coronary syndrome (NSTE-ACS), or ischemia-driven revascularization.

Ethical Approval:

Before beginning the study, it was accepted from the Ethics Committee in Benha University. An official agreement was taken from every patient. This study was designed to match with the Code of Ethics of the National Association Ethical Approval (Announcement of Helsinki) for researches including human being {0MS:24.12.2021}.

Statistical Methods:

Data administration and statistical examination were prepared using SPSS version 25 (IBM, Armonk, US). Quantitative data were calculated for normality using Kolmogorov–Smirnov test and direct data imagining methods. Numerical data were showed as means and SD. Categorical data were summarized as numbers and percentages. Quantitative data were compared between study groups using independent t-test. Categorical data were processed using the Chi-square or Fisher's exact test. Area Under Curve with 95% confidence interval, best cutoff point, and diagnostic indices- were calculated for each. P values less than 0.05 considered significant [(9)].

Results:

Demographics: There was no significant statistical difference between complete vs. culprit-only revascularization groups as regarding: age (mean ± SD age in years were 61.76 ± 10.75 vs. 62.36 ± 9.77 respectively, p= 0.721) and gender as group I included 60 males (80%) and 15 (20%) females vs. 59 (78.67%) males and 16 (21.33%) females in group II, without any statistically significant difference (p=0.84) (Table 1). *Baseline clinical characteristics:* there were no significant differences observed between the two groups as regard to clinical risk factors. Hypertension was found in 36 patients (48%) of group I, vs. 38 patients (50.67%) of group II (p=0.744), the same with diabetes (p=0.836), dyslipidemia (p=0.867), current smoking (p=0.739), and CKD- which was recorded amongst 2 patients (2.67%) of each group (p=1). Previous myocardial infarction was found between 5 patients (6.67%) of group I vs. 6 patients (8%) of group II (p=0.754), as was prior PCI. Previous stoke was found among 2 patients (2.67%) of each group (p=1) (Table 1). Regarding time from symptom onset to index PCI among the study groups, there was no statistically significant difference between both groups; as 53 patients (70.67%) vs. 49 patients (65.33%) presented before 6 hours of symptoms onset of groups I and II respectively, while 11 patients (14.67%) vs. 15 patients (20%) presented at 6-12 hours of groups I and II respectively, while the remaining 11 patients (14.67%) of each group- had presented after 12 hours of symptoms onset (p= 0.68) (Table 2). *Baseline laboratory results:* Glycated hemoglobin showed no statistically significant difference between the two groups (p=0.79). there were no statistically significant differences between both groups neither in Low-density lipoprotein cholesterol (LDL - C) levels which were 3.14±1.13 vs. 3.19±1.11 in groups I and II, respectively (p= 0.754), nor in peak creatinine levels (p=0.863) (Table 2). There was no statistically significant difference between the two studied groups regarding Killip class, where 8 patients of each group (10.67%) were in Killip class II or more (p=1) (Table 2).

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Table (1): Patients' demographic characteristics.

		Group I **No. = 75**	Group II **No. = 75**	Test of sig.	P-value	Sig.
Gender	Female	15 (20%)	16 (21.33%)	2.053*	0.84	NS
Age per year	Mean ± SD	61.76 ± 10.75	62.36 ± 9.77	0.358	0.721	NS
HTN	No. (%)	36 (48%)	38 (50.67%)	0.107	0.744	NS
DM	No. (%)	14 (18.67%)	15 (20%)	0.043	0.836	NS
Dyslipidemia	No. (%)	29 (38.67%)	30 (40%)	0.028	0.867	NS
Smoking	No. (%)	31 (41.33%)	29 (38.67%)	0.111	0.739	NS
CKD	No. (%)	2 (2.67%)	2 (2.67%)	0	1	NS
Prior MI	No. (%)	5 (6.67%)	6 (8%)	0.098	0.754	NS
Prior PCI	No. (%)	5 (6.67%)	6 (8%)	0.098	0.754	NS
Prior stroke	No. (%)	2 (2.67%)	2 (2.67%)	0	1	NS

HTN: Hypertension, DM: Diabetes Mellitus, CKD: chronic Kidney Disease, MI: Myocardial Infarction, PCI: Percutaneous Coronary Intervention.

Table (2): Clinical data and baseline laboratory results among 2 groups.

		Group I **No. = 75**	Group II **No. = 75**	Test of sig.	P-value	Sig.
Time from	<6 hours	53 (70.67%)	49 (65.33%)			
Symptoms Onset	6-12 hours	11 (14.67%)	15 (20%)	0.77	0.68	NS
to index PCI	>12 hours	11 (14.67%)	11 (14.67%)			
Killip Class	≥ II	8 (10.67%)	8 (10.67%)			
	< II	67 (89.33%)	67 (89.33%)	0	1	NS
HbA1c	Mean ± SD	6.3 ± 1.61	6.37 ± 1.51	0	1	NS
	Range (min-max)	7.8 (2.9 - 10.7)	6.9 (2.8 - 9.7)			
LDL-C	Mean ± SD	3.14 ± 1.13	3.19 ± 1.11	0.098	0.754	NS
(mmol/L)	Range (min-max)	5 (1 - 6)	5 (0.3 - 5.3)			
Peak creatinine	Mean ± SD	84.67 ± 10.9	84.96 ± 9.91	0.098	0.754	NS
(µmol/l)	Range (min-max)	45.3 (58.8 - 104.1)	52.7 (55.3 - 108)			

HbA1c: Glycated hemoglobin, LDL-C: Low Density Lipoprotein Cholesterol.

Anatomical considerations: there were no statistically significant differences between the two groups regarding both culprit [8.77±1.3 vs. 8.58±1.2 and 4.58±0.8 vs. 4.59±0.71] respectively (p> 0.05) (Table 3). Similarly, the location of culprit and non-culprit lesions among the study groups, showed no significant differences (p= 0.746 and 0.738 respectively) (Table 3). *Primary outcome:* The primary outcome- composite of 90-days cardiovascular death or MI- took place in 6 patients (8%) of group I vs. 9 patients (12%) of group II, without statistically significant difference between both groups (p=0.414). However, key *secondary outcome*- either of 90-days all-cause death, MI, NSTEACS, or ischemia-driven revascularization- occurred in 12 patients (16%) of group I vs. 32 patients (42%) of group II, which showed significant statistical difference between the two studied groups (p<0.001),(Table 4). Ninety days CV death and 90-days MI- occurred in 2 patients (2.67%) vs. 3 patients (4%) and in 4 patients (5.33%) vs. 6 patients (8%) of groups I and II, respectively (p>0.05) (Table

4). Ninety days all-cause death occurred in 3 cases (4%) of group I vs. 4 cases (5.33%) of group II, which was statistically non-significant (p=0.699). Ninety days MI aforementioned in previous paragraph, and the 90-days NSTE-ACS occurred to 2 patients (2.67%) of group I vs. 9 patients (12%) of group II, with statistically significant difference between both groups (p=0.028). Similarly, the 90-days ischemia driven revascularization- was statistically significant as it occurred in 2 patients (2.67%) of group I vs. 13 patients (17.33%) of group II (p=0.008) (Table 4). Other outcomes and complications among the study groups: there was no statistically significant difference between the two studied groups as regard strokes incidence (p=0.56), or NYHA class IV heart failure-which occurred at same rate between both groups (p=1), same goes for stent thrombosis and major bleeding; each (p=1). Also, there wasn't statistically significant difference regarding Contrast Induced Acute Kidney Injury (CIAKI) which affected 2 patients (2.67%) in group I vs. 1 patient in group II (p=0.56) (Table 4).

Table (3): Coronary anatomical data.

		Group I **No. = 75**	Group II **No. = 75**	Test of sig.	P-value	Sig.
Culprit lesion location	LM	1 (1.33%)	0 (0%)	1.228	0.746	NS
	LAD	24 (32%)	25 (33.33%)			
	LCX	14 (18.67%)	12 (16%)			
	RCA	36 (48%)	38 (50.67%)			
Non-culprit lesion(s) location	LM	1 (1.33%)	0 (0%)	1.264	0.738	NS
	LAD	28 (37.33%)	31 (41.33%)			
	LCX	27 (36%)	27(36%)			
	RCA	19 (25.33%)	17 (22.67%)			
Culprit lesion Specific Syntax score	Mean ± SD.	8.77 ± 1.3	8.58 ± 1.2	0.891	0.374	NS
	Range (min-max)	6.6 (5.1 - 11.7)	6.5 (5.2 - 11.7)			
Non-culprit lesion specific Syntax score	Mean ± SD.	4.58 ± 0.8	4.59 ± 0.71	0.065	0.948	NS
	Range (min-max)	4.4 (2.2 - 6.6)	3.7 (2.6 - 6.3)			

LM: Left Main artery, LAD: Left Anterior Descending artery, LCX: Left Circumflex artery, RCA: Right Coronary Artery, SYNTAX: The SYNergy between percutaneous coronary intervention with TAXus and cardiac surgery.

Table (4): Ninety days primary and secondary outcome.

		Group I **No. = 75**	Group II **No. = 75**	Test of sig.	P-value	Sig.
Primary outcome	Composite MI or CV death	6 (8%)	9 (12%)	0.545	0.46	NS
	MI	4(5.33%)	6(8%)	0.429	0.513	NS
	CV death	2(2.67%)	3(4%)	0.207	0.649	NS
Secondary outcome	All-cause death	3(4%)	4(5.33%)	0.15	0.699	NS
	NSTE-ACS	2(2.67%)	9(12%)	4.807	0.028	S
	Ischemia-driven revascularization	3(4%)	13(17.33%)	6.996	0.008	S

MI: Myocardial Infarction, CV: Cardiovascular, NSTE-ACS: Non-ST-segment elevation Acute Coronary Syndrome.

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Discussion

Baseline characteristics: In our present stud there were no significant differences between the two studied groups regarding the demographic characteristics between the two studied groups. This came in concordance with another trial comparing complete versus culprit-only revascularization [10]. Also, regarding baseline clinical characteristics and major risk factors that included current smoking, hypertension, diabetes, dyslipidemia and CKD among the two studied groups, there were no statistically significant differences between both groups in our current study [11]. Same goes for time to representation between symptoms onset to index PCI and the Killip class at presentation- was insignificantly different between the complete vs. culprit-only revascularization groups, which came in concordance with another study evaluating the complete vs. culprit lesion only revascularization in STEMI patients with multivessel disease [12,13]. In our study there were neither statistically significant differences between the studied groups regarding baseline laboratory results which included glycated hemoglobin (HbA1c), low-density lipoprotein cholesterol (LDL-C), and peak Creatinine levels- which were consistent with other older study [14], nor significant differences between the complete vs. culprit-only revascularization groups regarding the adjunctive pharmacotherapy which were consistent with other study of preventive angioplasty in myocardial infarction [15]. *Baseline anatomical data;*in our current study there weren't statistically significant differences between the studied groups regarding neither the location of culprit and non-culprit lesions, nor the culprit lesion specific SYNTAX and the non-culprit lesion(s) specific SYNTAX scores. This came in concordance with another older study [10]. *Outcome;* the primary outcome in our study was the composite of CV death or myocardial infarction which occurred at statistically insignificant difference between both groups. Also, each of them individually occurred at insignificant differences between the complete and culprit-only revascularization groups. In concordance with our study, came the primary outcome in an older meta-analysis [16]. However, and different to our primary outcome result came the outcome of another meta-analysis assessing complete revascularization by percutaneous coronary intervention for patients with STEMI and multivessel coronary artery disease, at which the CV mortality occurred at significantly lower rates in the complete vs. culprit-only revascularization group ($p<0.05$) [17]. These different findings in the meta-analysis can be explained by the longer mean duration follow-up and the larger sample size. The secondary outcomes in our current study consisted of any of: all-cause mortality, MI, NSTE-ACS or ischemia driven revascularization- which occurred at significantly lower rates in the complete revascularization group compared to the culprit-only revascularization group. The individual all-cause death occurrence- was insignificantly different between the studied groups in our current study. Consistently with our results, the one-year all-cause mortality rate wasn't significantly different between the two groups in previous study occurred to 5.4% vs. 5.9% in the complete vs. culprit-only revascularization groups respectively ($p=0.388$) [18]. In our study the incidence of NSTE-ACS- was significantly lower in the complete revascularization group vs. culprit-only revascularization group. This came in concordance with older study showing significantly lower incidence of unstable angina representing 3.5% vs. 6.4% of the respective complete and culprit-only revascularization groups ($p<0.05$) [10]. In the current study the ischemia-driven revascularization occurred at significantly lower rates in the complete vs. culprit only revascularization group. This came in concordance meta-analysis showing significantly lower incidence of ischemia-

driven revascularization ($p<0.01$) [15]. The other secondary outcomes and complications in our study entailed strokes, NYHA class IV heart failure, stent thrombosis, major bleeding, and contrast-induced acute kidney injury; every one of which occurred at non-significantly different rates between the complete and culprit-only revascularization groups. This came in concordance with older study [19].

Conclusion:

This study showed that in STEMI patients with multivessel disease, complete revascularization as compared to culprit-only revascularization strategy- reduced MACE and improved outcome.

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