

# Follow up of Complete Revascularization versus Culprit Revascularization in ST Segment Elevation Myocardial Infarction Patients Undergoing Primary Percutaneous Coronary Intervention

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## Abstract

**Objectives:** To compare between only Culprit revascularization versus total revascularization in patients with ST-elevation myocardial infarction undergoing primary PCI with 6 months follow up of occurrence of major adverse cardiovascular events (MACCE). **Methods:** 50 patients were enrolled in this study during the period from 1/11/2018 to 1/11/2019 at Menoufiya University and national heart institute. All patients present with acute ST-elevation myocardial infarction within 24 hours of onset of symptoms, and have multi vessel coronary artery disease on angiography suitable for PCI. Patients were subjected to detailed medical history, physical examination, and electrocardiography. **Results:** 50 patients with acute ST-elevation myocardial infarction (28 females and 22 males) underwent primary percutaneous coronary intervention. 25 patients had total revascularization to all coronary arteries, the other 25 patients had only culprit revascularization. We found that there was a significant reduction in the incidence of recurrent chest pain and non-fatal Myocardial infarction in the total revascularization group. **Conclusion:** Our study showed that Multivessel revascularization resulted in an improved clinical course and a significant reduction of MACCE regarding non-fatal MI and a significant reduction of recurrent chest pain.

## Keywords

Coronary Artery Disease, Myocardial Infarction, Primary Percutaneous Coronary Intervention, Major Cardiovascular Adverse Events

## 1. Introduction

Cardiovascular disease is the major global cause of death by 17.3 million deaths per year, which expected to be more than 23.6 million by 2030 [1].

Cardiovascular disease is the major cause of morbidity and mortality in developed countries [2].

Primary percutaneous coronary intervention is the most effective available method to reestablish coronary perfusion in patients presenting with ST-elevation myocardial infarction (STEMI) [3].

Primary percutaneous coronary intervention in acute myocardial infarction results in greater patency of infarct-related artery, the lower rate of death, reinfarction, and stroke when compared with fibrinolysis alone [4].

The prevalence of multivessel disease in patients present with STEMI approaches 40% [5].

The conventional strategy of primary PCI in STEMI usually involves selective intervention of infarct-related artery (IRA) (Culprit only revascularization) with treatment for significant non IRA in patients with multivessel disease (M.V.D) performed later (Staged PCI) [6].

Early revascularization of infarct-related artery (IRA) by (PPCI) is recommended by guidelines, but strategy for treatment of non-infarct-related artery still controversial especially in hemodynamically unstable patients [6].

In this study, we compare effects between PPCI to infarct-related artery (Culprit only revascularization) and those with infarct-related artery and non-infarct related artery (Total revascularization) in patients with STEMI [7].

Since starting using primary PCI in the treatment of STEMI, a debatable issue was raised.

When to treat all diseased coronary vessels, and when to treat only culprit vessel.

What is more beneficial to the patients, in this study, we will try to give an answer.

## 2. Methods

### Study Design

This is a prospective study has been hold at national heart institute and Menoufiya University.

50 patients were enrolled in this study during the period from 1/11/2018 to 1/11/2019 at Menoufiya University and national heart institute. Patients were subdivided into Group (A): consist of 25 patients had culprit PCI in whom PCI done for culprit only lesion. Group (B): consist of 25 patient had full revascularization in whom PCI done for infarct-related artery.

(IRA) and non-infarct related artery (non INR).

Inclusion criteria:

All patients:

- Present with acute ST-elevation myocardial infarction within 24 hours of

onset of symptoms.

- Have multivessel coronary artery disease on angiography suitable for PCI.

Exclusion criteria:

- Left main coronary artery disease.
- Any contraindications for antiplatelet therapy.
- Patient in whom non IRA is less than 2.5 mm.

#### Study Population

All patients presenting with acute ST-elevation myocardial infarction within 24 hours of onset of symptoms and Have multivessel coronary artery disease on angiography suitable for PCI. Multivessel disease defined as the presence of at least one lesion more than 70% in major epicardial vessel or one of its branches other than the infarct-related artery. Exclusion criteria was left main coronary artery disease, Any contraindications for antiplatelet therapy and patient in whom non IRA is less than 2.5 mm. PCI. Patients were subjected to detailed medical history, physical examination, and electrocardiography.

Demographic data: name, age, gender (28 females and 22 males), date of admission and discharge, address and telephone number. Detailed history and clinical examination include risk factors of coronary heart disease as hypertension (28 patients were hypertensive), smoking (38 patients were smoker), diabetes mellitus (21 patients were diabetic), dyslipidemia (27 patients were hyperlipidemic), age and family history of cardiovascular disease (6 patients have family history). Hypertension is said to be present if blood pressure is often at or above 140/90mmHg. Diabetes mellitus is said to be present by demonstrating any one of the following: Fasting plasma glucose level  $\geq 7.0$  mmol/l (126 mg/dl). Plasma glucose  $\geq 11.1$  mmol/l (200 mg/dl) two hours after a 75 g oral glucose load as in a glucose tolerance test. Symptoms of hyperglycemia and casual plasma glucose  $\geq 11.1$  mmol/l (200 mg/dl). Glycated hemoglobin (Hb A1C)  $\geq 6.5\%$ .

Electrocardiogram to diagnose patient with ST elevation myocardial infarction (STEMI).

#### Statistical Analysis

Statistical presentation and analysis of the present study were conducted, using the mean, standard Deviation, unpaired student t-test and chi-square tests by (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.).

Mean =  $\frac{\sum x}{n}$  where  $\Sigma$  = sum &  $n$  = number of observations.

Standard Deviation [SD]:

$$SD = \sqrt{\frac{\sum |x - \bar{x}|^2}{n - 1}}$$

Student t-test [Unpaired]:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{SE_1^2 + SE_2^2}}$$

where:

$\bar{X}_1$  /= Mean of the first group.

$\bar{X}_2$  /= Mean of the second group.

SE1 = Standard error of the first group.

SE2 = Standard error of the second group.

Unpaired Student T-test was used to compare between two groups in quantitative data.

Chi-square:

The hypothesis that the row and column variables are independent, without indicating strength or direction of the relationship. Pearson chi-square and likelihood-ratio chi-square. Fisher's exact test and Yates' corrected chi-square are computed for  $2 \times 2$  tables. More than 0.05 is non-significant, less than 0.05 is significant, less than 0.001 is highly significant.

### 3. Results

This is an observational non-randomized study that included fifty patients Presented with STEMI and underwent primary PCI in the period from 1/11/2018 to 1/11/2019 in the Menoufiya University and National Heart Institute.

The 50 patients were classified into two groups:

Group A: patients had culprit PCI in whom PCI done for culprit only lesion (n = 25).

Group B: patients had full revascularization in whom PCI done for IRA and non INR (n = 25).

Regarding risk factors:

There are significant differences between females underwent total revascularization and those who had culprit only revascularization (84% vs. 28%), Males underwent only culprit revascularization are significantly more than males had total revascularization (72% vs. 16%). Diabetic patients who underwent total revascularization are statistically significant than those had culprit revascularization (56% vs. 28%).

There is no significant difference regarding HTN, dyslipidemia, Prior PCI, Post-menopause and family history (**Table 1, Figure 1, Figure 2**).

Regarding angiographic data:

There are significant differences regarding number of stents between study groups (84% vs. 16%). There is no significant difference regarding type of MI, dilatation, guide wire, TIMI flow pre and post, culprit artery and non infarct related artery (**Table 2 & Figure 3**).

Regarding 6 months follow up of MAAACE:

There is significant difference in non-fatal MI (20% vs. 0%) and recurrent chest pain (36% vs. 12%) between study groups. There is no significant difference regarding mortality, heart failure, further revascularization, Stroke and No events (**Table 3**).

Regarding clinical presentations:

There is no significant difference between the two groups regarding KILLP classifications, life threatening arrhythmia, pulse and mean arterial blood pressure (**Table 4**).

Regarding PCI time and contrast:

There are significant differences between the two groups regarding PCI time and PCI contrast (Table 5 & Figure 4). This is logic as time needed to dilate and stent multiple vessels is more than single vessel, also contrast used in total revascularizations is more than used in only culprit revascularization (Figure 5).

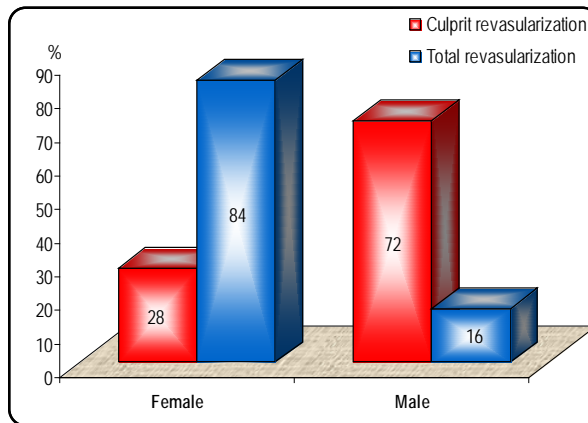


Figure 1. Patients risk factors.

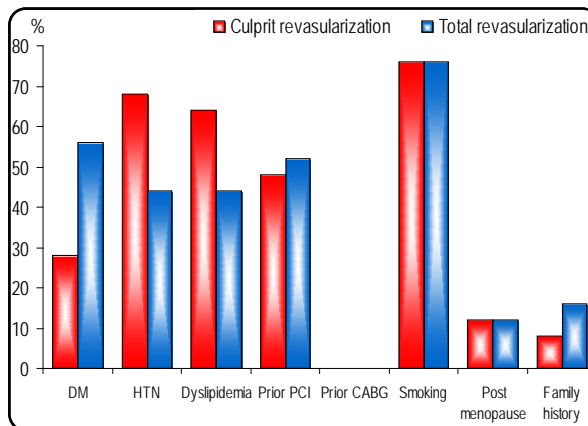


Figure 2. Patients risk factors.

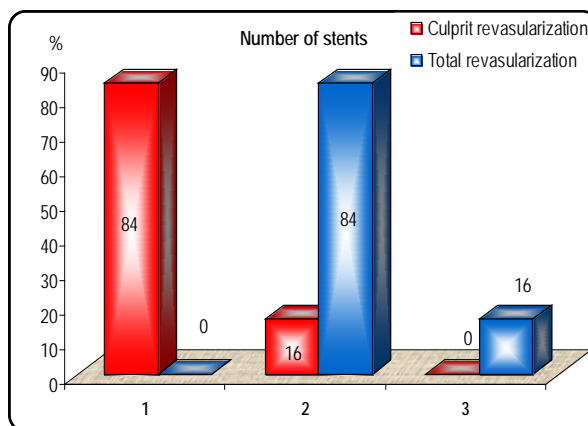
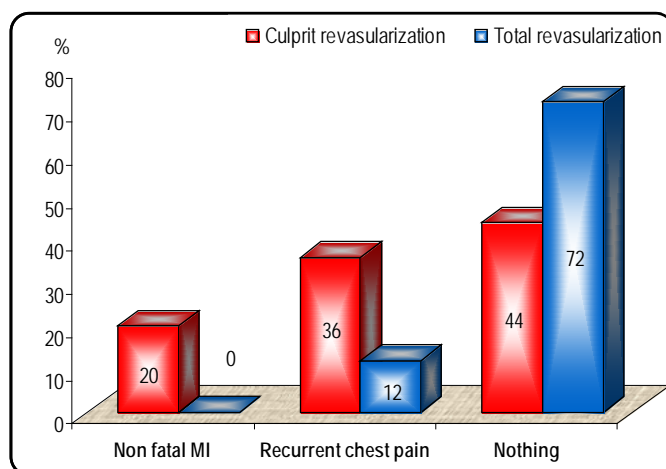
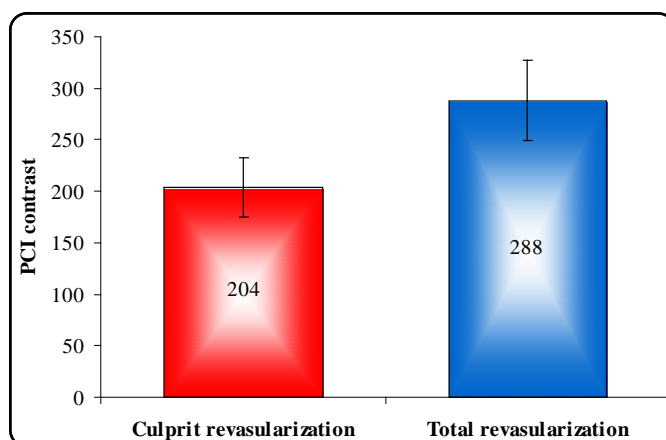


Figure 3. Number of stents.



**Figure 4.** six months follow up.



**Figure 5.** PCI contrast volume.

**Tabel 1.** Patients risk factors.

		Groups						Chi-square	
		Culprit revascularization		Total revascularization		Total			
		N	%	N	%	N	%	X <sup>2</sup>	P-value
<b>Sex</b>	Female	7	28	21	84	28	56	15.909	<0.001**
	Male	18	72	4	16	22	44		
	<b>DM</b>	7	28	14	56	21	42	4.023	0.045*
	<b>HTN</b>	17	68	11	44	28	56	2.922	0.087
	<b>Dyslipidemia</b>	16	64	11	44	27	54	2.013	0.156
	<b>Prior PCI</b>	12	48	13	52	25	50	0.080	0.777
	<b>Post menopause</b>	3	12	3	12	6	12	0.000	1.000
	<b>Family history</b>	2	8	4	16	6	12	0.758	0.384

**Table 2.** Details of the procedure.

		Groups						Chi-square	
		Culprit revascularization		Total revascularization		Total			
		N	%	N	%	N	%	X <sup>2</sup>	P-value
<b>Type of MI</b>	Ant	13	52	14	56	27	54	0.081	0.777
	Inf	12	48	11	44	23	46		
<b>Dilataion</b>		16	64	18	72	34	68	0.368	0.544
		PT2ms	5	20	2	8	7	14	
<b>Guiding Wire</b>	BMW	14	56	17	68	31	62	1.576	0.455
	ASAHI soft	6	24	6	24	12	24		
<b>Number of stents</b>	1	21	84	0	0	21	42	36.560	<0.001**
	2	4	16	21	84	25	50		
	3	0	0	4	16	4	8		
<b>TIMI flow pre</b>	0	20	80	18	72	38	76	0.439	0.508
	I	5	20	7	28	12	24		
<b>TIMI flow post</b>	II	1	4	0	0	1	2	1.020	0.312
	III	24	96	25	100	49	98		
	LAD	13	52	16	64	29	58		
<b>Culprit artery</b>	RCA	7	28	8	32	15	30	3.044	0.218
	LCX	5	20	1	4	6	12		
<b>Non infarct related arteries</b>	LAD	8	32	10	40	18	36	0.967	0.617
	RCA	9	36	10	40	19	38		
	LCX	8	32	5	20	13	26		

**Table 3.** 6 months follow up.

		Groups						Chi-square	
		Culprit revascularization		Total revascularization		Total			
		N	%	N	%	N	%	X <sup>2</sup>	P-value
<b>Type of MI</b>	Ant	13	52	14	56	27	54	0.081	0.777
	Inf	12	48	11	44	23	46		
<b>Mortality</b>		1	4	1	4	2	4	0.000	1.000
<b>Non fatal MI</b>		5	20	0	0	5	10	5.556	0.018*
<b>Recurrent chest pain</b>		9	36	3	12	12	24	3.947	0.047*
<b>Heart failure</b>		3	12	2	8	5	10	0.222	0.637
<b>Further revascularization</b>		3	12	1	4	4	8	1.087	0.297
<b>Stroke</b>		0	0	0	0	50	0		
<b>No events</b>		11	44	18	72	31	62	4.023	0.045*

**Table 4.** Clinical presentations.

		Culprit revascularization	Total revascularization	Tests	
				T or X <sup>2</sup>	P-value
<b>Kilip class</b>	I	19 (76%)	20 (80%)	0.117	0.733
	II	6 (24%)	5 (20%)		
<b>Life threatening arrhythmia</b>		5 (20%)	4 (16%)	0.136	0.713
<b>Pulse</b>	Range	40 - 120	40 - 180	1.901	0.063
	Mean ± SD	82.20 ± 20.21	97.40 ± 34.49		
<b>Mean ABP</b>	Range	70 - 130	80 - 120	0.000	1.000
	Mean ± SD	102.00 ± 13.62	102.00 ± 14.43		

**Table 5.** Door to balloon , PCI time and PCI contrast.

	Groups	Range	Mean	±	SD	T-test	
						T	P-value
<b>Door to balloon</b>	Culprit revascularization	40 - 120	68.80	±	19.65	5.386	<0.001**
	Total revascularization	60 - 140	99.00	±	20.00		
<b>PCI time</b>	Culprit revascularization	30 - 90	45.40	±	11.45	2.223	0.031*
	Total revascularization	40 - 90	52.40	±	10.81		
<b>PCI contrast</b>	Culprit revascularization	150 - 250	204.00	±	28.58	8.695	<0.001**
	Total revascularization	200 - 350	288.00	±	38.94		

## 4. Discussion

Recent studies suggest that acute coronary syndromes, including AMI, may result from a systemic inflammatory process, causing multiple unstable lesions. Thus, a strategy of multivessel PCI in the peri-infarct period may be important in improving the outcomes of primary PCI [8].

Such an attempt of complete revascularization may prevent recurrent ischemia from “non-infarct-related” lesions, obviating the need for repeat intervention, and also possibly improves the late outcome by reducing the ischemic burden following myocardial damage [9].

Contemporary guidelines recommend PCI only to the IRA during the urgent procedure, leaving the other stenosed vessels untreated (culprit-only revascularization) or to dilate during a second elective procedure (staged revascularization). Simultaneous treatment of IRA and non-IRA is recommended only in patients with cardiogenic shock [10].

Among patients with STEMI and multivessel disease undergoing primary PCI, complete revascularization was superior to culprit-only revascularization. Complete revascularization was beneficial if performed either during or after the index hospitalization. Complete revascularization was associated with a reduction in cardiovascular death or MI. This was accomplished without an increase in major bleeding or contrast-induced nephropathy [11].

The current study evaluated the 6-month outcome of culprit only revascularization compared to total revascularization in the setting of STEMI with MVD.

The principle finding of the present study is:

There was significant increase in the duration of PCI & volume of contrast in the Total revascularization group.

There was no significant reduction in (Mortality and Stroke) between both groups.

There was significant reduction in recurrent chest pain and non-fatal MI in the Total revascularization group.

This was discordant with Corpus *et al.*, 2004 which was nonrandomized study comparing between culprit PCI VS culprit and multivessel PCI electively subdivided into early PCI (1 month) or late (more than 1 month and less than 6 months) and enrolled 506 patients revealed that 30 days follow up of patients who underwent total revascularization had more fatal re-infarction and more MACEs than patients who underwent only culprit revascularization strategies. Also, the data observed in Roe *et al.*, 2001 which was non-randomized study comparing culprit PCI VS culprit PCI and multivessel PCI during index catheterization and enrolled 158 patients showed that multivessel PCI may be associated with an increased risk of adverse outcomes, also Moreno *et al.*, 1998 found that patients with MVD who underwent total revascularization during primary angioplasty for STEMI, had higher rate of in hospital & 30 days mortality than those undergoing culprit revascularization strategy. Also, Hannan *et al.*, 2010 which was governmental non-randomized study enrolled 1434 patients found that patients with multivessel disease STEMI who underwent multivessel primary PCI had mortality rates that were higher than rates for patients with culprit vessel PCI alone [12].

On the other hand, this is agreed with other trials, like Ijsselmuiden *et al.*, 2004 who found that multivessel approach had better outcome by decreasing the need for further revascularization. Qarawani *et al.*, 2007 which was non-randomized study enrolled 120 patients, observed that patients who underwent total revascularization during PPCI had lower incidence of further revascularization. Also, Politi *et al.*, 2010 which was randomized study enrolled 149 patients suggested that the multivessel approach was safe and possibly less expensive than an incomplete approach by reducing the probability of further unplanned procedures and without affecting the length of hospitalization. Also, Di mario *et al.*, 2004 which was randomized study comparing between culprit PCI with additional revascularization at the investigators discretion VS culprit PCI with immediate multivessel treatment during index catheterization enrolled 69 patients showed that there was no excess in-hospital or 1-year MACE (defined as death, repeat MI, urgent PTCA, or CABG) associated with complete revascularization [13].

PRAMI study held in the United Kingdom enrolled 465 patients from 2008 through 2013, showed significant reduction in the number of death from cardiac causes, number of non-fatal MI (21 vs. 53,  $P < 0.001$ ) & number need to repeat

revascularization (16 vs. 46,  $P < 0.001$ ) in the total revascularization group in the long term follow up of the patients [14].

CVLPRIT study that also held in United Kingdom enrolled 296 patients through 2015 within 7 U.K. centers in 12 months follow up, there was significant reduction in MACE the total revascularization group (21 vs. 10,  $P < 0.001$ ) [15].

COMPARE-ACUTE study was an investigator-initiated, prospective, multi-center, randomized trial in which 885 patients underwent FFR-guided complete revascularization in the acute setting of primary PCI was compared with infarct-related, coronary-artery-only revascularization in patients with STEMI.

This showed significant reduction of MACE with incidence of all-cause death, MI, cerebrovascular event, or any revascularization at 12 months, occurred in 7.8% of the complete group versus 20.5% of the infarct artery only group ( $P < 0.001$ ) [16].

Also, COMPLETE study that held in 2019 enrolling 4,041 patients from different countries comparing between total vs. culprit revascularization agreed with our study showing significant reduction of MACE cardiovascular death, MI, or ischemia-driven revascularization: 8.9% with complete revascularization vs. 16.7% with culprit-only revascularization ( $P < 0.001$ ).

In the present study, the mean total duration of PCI was significantly higher in the total revascularization group than in the culprit group (52 + 12 vs. 44 + 10) min. this was concordant with Di Mario *et al.*, 2004 who reported that in TR group the mean PCI time was significantly higher in the Total revascularization group (69 + 38 vs. 53 + 24) min.

In the present study, the mean volume of contrast was significantly more in the Total group than in the culprit group (283 vs. 199 ml), this was agreed by the cvLPRIT study where the mean volume of contrast was significantly higher in the total group than in the culprit group (250 vs. 190) ml [17].

This was logic, because some extra time and contrast were needed to treat the non-culprit artery lesions.

In the present study, there was no significant statistical difference regarding Mortality (4% vs. 4% with p-value 1.000) or Stroke (0% in both groups), but there was a significant decrease in recurrent chest pain in the total revascularization group (36.0% vs. 12.0%) (p-value 0.47) and Non-fatal MI (20% vs. 0%) (p-value 0.18).

## 5. Study Limitations

Short Term follow up of the patients, small sample size and it was a non-randomized study.

## 6. Conclusions

Multivessel revascularization resulted in an improved clinical course and significant reduction of MACE regarding non-fatal MI and significant reduction in recurrent chest pain. Our findings support that multivessel PCI during STEMI

can be feasible and safe.

Decisions about PCI of the non-infarct vessel(s) should be individualized. Further large randomized trials with longer follow up will help us solve this dilemma.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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