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Angiographic Guided Complete Revascularization during Primary Index Percutaneous Coronary Intervention in a Resource Constraint Country

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Abstract

Background: A significant proportion of patients with ST-segment elevation myocardial infarction have multivessel coronary artery disease. Although several trials have compared complete with culprit-only revascularization in ST-segment elevation MI, it remains unclear whether complete revascularization may lead to improvement in hard endpoints (death and MI). Earlier trials showed that it is harmful to undergo complete revascularization in hemodynamically stable patient. Later on with the advancement of the time, these days, it is said that complete revascularization either index or staged PCI is superior to culprit only revascularization in hemodynamically stable patient.

Methods: This research was a prospective observational study of 130 cases conducted at Chitwan Medical College and Teaching Hospital, Chitwan. This study included all the consent given patients who presented with acute ST elevation myocardial infarction and underwent coronary angiography and found to have significant multivessel lesion from December, 2018 to May, 2021.

Results: Among 130 cases, 58 (44.6%) cases underwent complete revascularization and 72 (55.4%) cases underwent culprit only revascularization. Coronary angiogram showed double vessel disease in 92 (70.8%) and triple vessel disease 38 (29.2%). Compared with culprit only revascularization, complete revascularization significantly reduced the risk for death, MI and dreadful arrhythmias VT/VF (RR: 0.062; 95% CI: 0.002 to 0.122; p value 0.045) without much increase in CIN or major GI bleeding.

Conclusion: Complete revascularizations with pPCI during index procedure significantly reduce the combined endpoint of death, MI and dreadful arrhythmia without much difference in CIN and major GI bleed.

Keywords: Acute STEMI; Angiography; Complete revascularization; Index procedure; Outcome

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Introduction

Primary percutaneous coronary intervention is the gold standard of care for patients with acute ST-segment elevation myocardial infarction. Primary PCI is an emergency procedure used to open the significantly stenosed artery or completely blocked artery in the setting of acute myocardial infarction evidenced by ST elevation MI on the electrocardiogram and chest pain of ischemia clinically. In up to 40-50% of such patients, significant stenosis

are seen in one or more non-infarct related arteries during index angiography [1,2]. It remains unresolved whether complete revascularization should be undertaken in the index setting with historical data providing conflicting evidence on the benefit and safety of immediate complete revascularization versus delayed complete revascularization versus revascularization as clinically required. In several registry series, it is said that delayed complete revascularization appears to confer benefit whereas observational studies generally suggested no benefit and

possible harm from immediate complete revascularization [3,4]. The prevailing uncertainty regarding optimal management has persisted despite the recent trial which demonstrated benefit from complete revascularization during the index procedure [5]. Multi-vessel coronary artery disease is found in ST-segment elevation myocardial infarction undergoing revascularization by primary percutaneous coronary intervention and is associated with worse clinical outcomes and increased mortality [6-8] (Table 1).

There is no universal definition for complete revascularization. None of the current guidelines set out by the American or European cardiology societies formally discuss the issue in detail but it is declared complete if all ischemic myocardial territories are perfused or if all stenotic vessels are vascularized irrespective of size of the artery and territory supplied (Figure 1). There is still debate whether complete revascularization should be undertaken in the index setting even though there is conflicting evidence on the benefit and safety regarding immediate complete revascularization versus culprit only revascularization.

Mario Gössl et al. [9] proposed reasonable universal definitions of CR/IR incorporating current evidence are as follows:

1. Complete anatomical revascularization defined as treatment of all coronary artery segments >1.5 mm in diameter and $\geq 50\%$ diameter stenosis regardless of their functional significance.
2. Incomplete anatomical but functionally adequate revascularization defined as treatment of coronary segments with $\geq 50\%$ diameter stenosis and an FFR ≤ 0.8 , or $\geq 70\%$ diameter stenosis without FFR supplying viable myocardium.
3. Incomplete anatomical and functional revascularization defined as the inability to treat all coronary segments that have a $\geq 50\%$ to 70% diameter stenosis and an FFR ≤ 0.8 or $>70\%$ without FFR that supply a significant degree of viable myocardium.

Although several trials have compared complete with culprit-only revascularization in ST-segment elevation MI, it remains unclear whether complete revascularization may lead to improvement in hard endpoints (death and MI). Patients undergoing primary percutaneous revascularization have multi-vessel disease (MVD)

which is an adverse prognostic predictor of long-term outcome thereby not favouring revascularization of non-infarct-related artery lesions unless hemodynamically unstable before 2015. The European Society of Cardiology (ESC) guidelines on Myocardial Revascularization 2014 recommended pPCI for the culprit vessel but revascularization of additional lesions only in the case of cardiogenic shock [10]. Recent published trials such as PRAMI, CvLPRIT and DANAMI-3 PRIMULTI have questioned the need, timing and criteria to perform multi-vessel revascularization in patients with STEMI showing better outcomes with complete immediate revascularization (Table 2).

Methods

This research is a prospective observational study conducted at Chitwan Medical College, Bharatpur, Chitwan, Nepal. This study included all the consent given patients who presented with acute ST elevation myocardial infarction and underwent coronary angiography and found to have multivessel lesion which needs revascularization besides culprit vessel only from December, 2018 to May, 2021 and approved by ethical committee. Statistical analyses were performed using SPSS version 17 (Table 3). Data are expressed in frequencies (n), Percentage (%) and means \pm standard deviation (Mean \pm SD). Differences in baseline characteristics between complete revascularisation and culprit only revascularisation were evaluated with the independent samples t-test. A p-value of less than 0.05 was considered to be statistically significant (Figure 2).

Inclusion Criteria

All patients with acute STEMI who underwent coronary angiogram in CMCTH and found to have significant multi-vessel disease ($\geq 50\%$ stenosis in left main or $\geq 70\%$ stenosis in at least one non-infarct related epicardial coronary artery) from December, 2018 to May, 2021.

Exclusion Criteria

1. Patient with single vessel disease.
2. Patient with cardiac arrest or cardiogenic shock prior to intervention.
3. Patient who does not want to involve in study.

Table 1: Comparison of baseline characteristics between complete and culprit only revascularization during primary index PCI.

Feature	Revascularization types		p-value
	Complete revascularization	Culprit only revascularization	
Age	62.24 \pm 10.4	65.86 \pm 12.35	0.12
Male (%)	42 (72.4%)	38 (52.8%)	0.00
Female (%)	16 (27.6%)	34 (47.2%)	0.00
Smoker (%)	34 (58.6%)	60 (83.3%)	0.29
Hypertension (%)	20 (34.5%)	36 (50%)	0.05
Diabetes (%)	18 (31%)	28 (38.9%)	0.05
Dyslipidemia (%)	10 (17.2%)	10 (13.9%)	0.13
Family History of MI (%)	4 (6.9%)	2 (2.8%)	0.20
Tobacco Chewing (%)	12 (20.7%)	8 (11.1%)	0.22
High BMI (%)	40 (69%) 26.22 \pm 3.25	46 (63.9%) 25.65 \pm 2.90	0.10
Killip-I (%)	36 (62%)	56 (77.8%)	0.19
Killip-II (%)	22 (37.9%)	16 (22.2%)	0.00

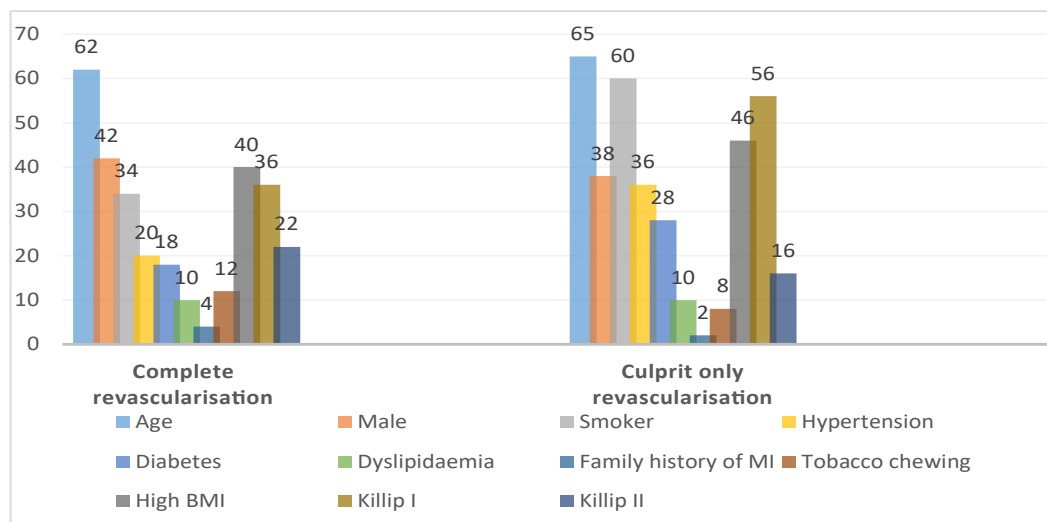


Figure 1: Comparison of baseline characteristics between complete and culprit only revascularization during pPCI.

Table 2: Coronary angiogram findings.

Feature	Total number	Complete Revascularisation	Culprit only Revascularisation
DVD	92 (70.8%)	52 (56.5%)	40 (43.5%)
TVD	38 (29.2%)	6 (15.8%)	32 (84.2%)

Table 3: Culprit vessel in multi vessel disease during Ppci.

Culprit Vessel Involved	Total number	Complete Revascularisation	Culprit only Revascularisation
LAD	70	24 (34.3%)	46 (65.7%)
LCX	22	12 (54.5%)	10 (45.5%)
RCA	38	22 (57.8%)	16 (42.1%)
Lt. Main	0	0	0

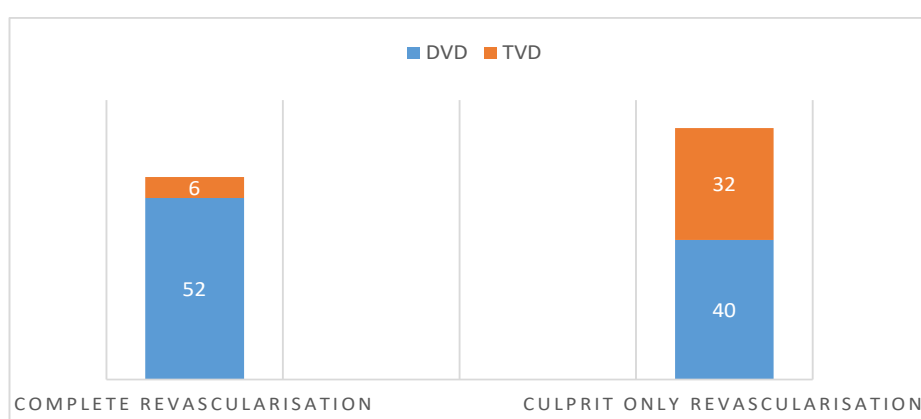


Figure 2: Coronary angiogram findings.

Results

In this study, we have taken 130 cases in total where 58 cases (44.6%) were under complete revascularization and 72 (55.4%) under culprit only revascularization (Table 4).

Among 130 cases, 58 (44.6%) cases underwent complete revascularization and 72 (55.4%) cases underwent culprit

only revascularization. The overall mean age of the included population being 64.25 ± 11.58 years with mean age among completely revascularised group was 62.24 ± 10.40 years and in culprit only revascularised group was 65.86 ± 12.35 years (Figure 3). In Complete revascularised group maximum and minimum age were 91 years and 41 years whereas in culprit only revascularised group, maximum and minimum age was 84 and 41 years (Table

5,6). It showed that there is no significant difference in average age between two groups. Generally, male population dominated female population with 61.5% and 38.5% respectively. Among them, in complete revascularised group, 32.3% were male and 12.3% were female whereas in culprit only revascularised group, male were 29.2% and female being 26.2%.

Smoking was the most common with 56.9% (n= 94) among which 46.1% (n=60) belongs to complete revascularization group and 26.1% (n=34) belongs to culprit only revascularised group. The second most common being high BMI (mean for the sample was 26.22 ± 3.25 in complete revascularised group and 25.65 ± 2.9 in culprit only revascularised group), hypertension and Diabetes

Table 4: Duration of hospital stay

Feature	Complete Revascularisation	Culprit only Revascularisation	P Value
Mean duration of hospital stay	5.28+ 1.13	5.08+ 1.48	0.037
Maximum duration of stay	11	10	
Minimum duration of stay	5	1	

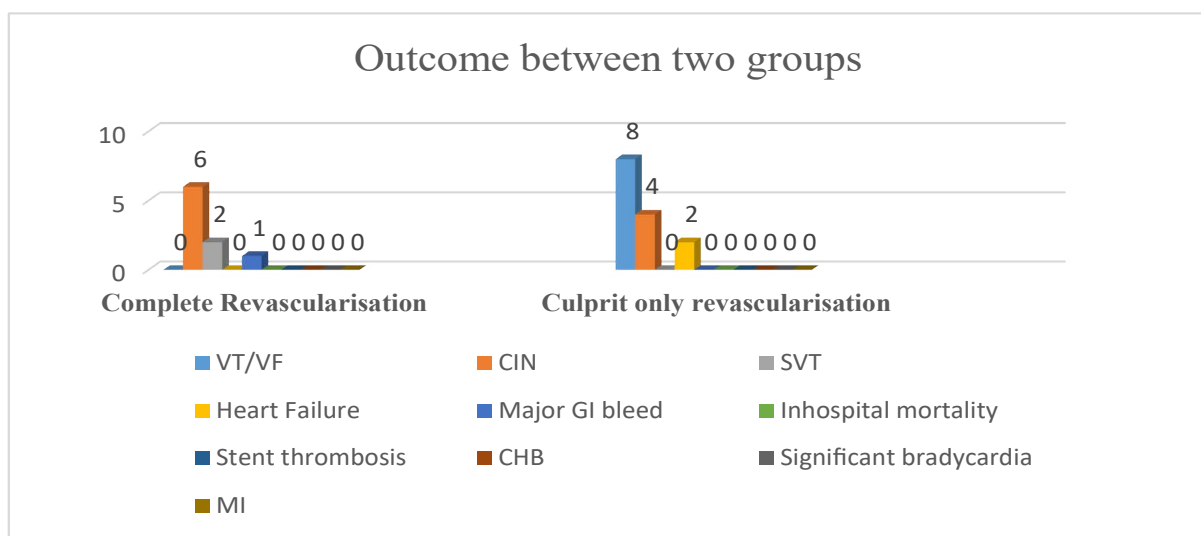


Figure 3: Outcome of complete versus culprit only revascularization during pPCI.

Table 5: pattern of arrhythmia during hospital stay between two groups

Feature	Complete Revascularisation	Culprit only Revascularisation	p Value
VT/VF	0	8 (11.1%)	0.030
SVT	2 (3.4%)	0	0.015
AF	0	0	
CHB	0	0	
Significant Bradycardia	0	0	

Table 6: Comparison of outcome between two group (N=130).

Feature	Complete Revascularisation(n=58)	culprit only Revascularisation (n=72)	p Value
Duration of hospital stay (days)	5.28+ 1.13	5.08+ 1.48	0.037
Ventricular arrhythmias including VT/VF	0	8 (11.1%)	0.030
Supraventricular arrhythmias (PSVT, Atrial Fibrillation)	2 (3.4%)	0	0.015
Heart Failure/ Pulmonary edema	0	2 (2.8%)	0.015
Ischemic Stroke	0	0	
Hemorrhagic Stroke	0	0	
Stent Thrombosis	0	0	
Myocardial infarction (MI)	0	0	
Significant Bradycardia	0	0	
Complete Heart Block	0	0	
Contrast Induced Nephropathy	6 (4.6%)	4 (3.1%)	0.019
Major GI Bleeding	2 (3.4%)	0	0.015
In-hospital Mortality	0	8 (11.1%)	0.030

and least are the family history of prior CAD or sudden cardiac death without obvious cause.

Among 130 cases, in around one-third of the patients emergent CAG showed three-vessel CAD. Emergent coronary angiographic findings were double vessel disease in 92 (70.8%) patients among whom 52 (56.5%) patient belong to complete revascularised group and 20 (43.5%) cases falls under culprit only revascularised group. 38 (29.2%) cases had triple vessel disease where 6 (15.8%) patient underwent complete revascularization and 32 (84.2%) cases underwent culprit only revascularization. 70 (53.8%) patients had LAD as a culprit lesion and LCX and RCA as a culprit lesion in 22(16.9%) and 38 (29.2%) cases. Among completely revascularised group, the LAD, LCX and RCA as a culprit being 24 (34%), 12 (54.5%) and 22 (57.8%) respectively whereas in culprit only revascularization group, LAD, LCX and RCA being the culprit in 46 (65.7%), 10 (45.45%) and 16 (42.1%) cases respectively. At presentation all patients (100%) were in Killip class I-II. Complete revascularisation was performed in 58 patients (44.6%) and culprit only revascularization in 72 patients (55.4%) during primary index PCI. The amount of contrast used in complete revascularised group was 231.72 ± 33.38 ml and 223.61 ± 30.44 ml in culprit only revascularised group which seems not much of difference. The procedural time was 66.43 ± 14.23 minutes and 64.44 ± 19.99 minutes respectively for complete and culprit only revascularised group respectively. Compared with culprit only revascularization, complete revascularization significantly reduced the risk for death from dreadful arrhythmias VT/VF (RR: 0.062; 95% CI: 0.002 to 0.122; p value 0.045) However, immediate complete revascularization had significant reductions in risk for death or MI or dreadful arrhythmias VT/VF (RR: 0.062; 95% CI: 0.002 to 0.122; p value 0.045. The overall incidence of CIN was very low (4.6% vs. 3.1%), with slight difference between complete and culprit only groups. Contrast induced nephropathy was almost similar in complete revascularization (RR: 1.10, 95% CI: 0.99 to 1.22, p value: 0.58) as well as in culprit only revascularization (RR: 1.06, 95% CI: 0.98 to 1.13, p value: 0.39). The total duration of hospital stay in complete revascularization group was 5 ± 1.13 days (maximum 11 days and minimum 5 days) whereas in culprit only vascularised group, the total duration of hospital stay was 5.08 ± 1.48 days (maximum being 10 days and minimum being 1 day).

Eight patients (11.1%) died during index hospitalization in culprit only revascularization group. The cause of death was cardiac in all the patients. The cardiac causes of death were ventricular tachycardia/ventricular fibrillation. One each patient had major GI bleed and supraventricular tachycardia in complete revascularization group.

The incidence of CIN was very low (4.6% vs. 3.1%), with slight difference between complete and culprit only revascularised groups respectively. Contrast induced nephropathy was almost similar in complete revascularization (RR: 1.10, 95% CI: 0.99 to 1.22, p value: 0.58) as well as in culprit only revascularization (RR: 1.06, 95% CI: 0.98 to 1.13, p value: 0.39). Acute stent thrombosis, Stroke and Complete heart block were not identified in both the group. The access site for intervention is femoral in all the participated patients.

Discussion

Early observational studies during 2012 did not show signs of benefit from complete revascularization in patients with acute STEMI but later on different trial showed that complete revascularization during primary percutaneous coronary intervention settings in a hemodynamically stable significantly reduce the risk for death or MI. Accordingly, the 2012 European Society of Cardiology guidelines allowed complete revascularization as a Class IIb indication while current 2017 guidelines give this strategy a Class IIa indication [11], whereas the American College of Cardiology/American Heart Association guidelines have moved from Class III (2012) to Class IIb (2015) [12].

Multivessel CAD is present in 40%–50% of patients presenting with acute STEMI and is associated with 1.5-fold higher 30-day mortality rate compared with patients with STEMI with single-vessel CAD [13-15]. It has been hypothesised that complete revascularisation may improve the outcome of patients with acute STEMI and multivessel CAD. However, the results of various registries and randomised trials are conflicting [16-19]. The randomised CvLPRIT trial demonstrated in 296 patients with STEMI and multivessel CAD a significant reduction of the combined end point consisting of all-cause mortality, recurrent myocardial infarction or heart failure in the complete revascularisation group compared with the IRA-only PCI group (4.7% and 13%; $p=0.025$). However, data of the large National CV Data Registry from the USA that involved 28 936 patients with STEMI with multivessel CAD, demonstrated a significantly higher mortality rate in patients with multivessel PCI in comparison with IRA-only PCI [7].

Patients treated with a culprit-only strategy will have significant non-infarct related coronary stenosis left untreated which leads to new revascularizations whereas the preventive treatment of significant non-infarct coronary stenosis in the acute phase predictably reduce the need for further revascularization [20].

In this study, the mean age among completely revascularised group was 62.24 ± 10.40 years and in culprit only revascularised group was 65.86 ± 12.35 years ($p=0.12$). It showed that there is no significant difference in age between two groups which was similar with Haichu Yu et al (>45 years) [21], Judith S et al (66 ± 10 years) and Yousif Ahmad et al (62 years). Smoking in this study in complete revascularization group was 58.6% and 83.3% belongs to culprit only revascularised group which was similar to junhua Ge42, Jian Li and Haichu Yu et al. (60% to 90%). In this study, one-third of the patients with emergent CAG showed three-vessel CAD. Emergent coronary angiographic findings had double vessel disease in 92 (70.8%) patients and 38 (29.2%) cases had triple vessel disease which was dissimilar with Paul Sorajja et al. (33.2% and 15.6% respectively because of large number of patients they had included in their study. Haiyan Xu et al. showed that CR was associated with significantly lower rates of major adverse cardiac events (MACE) (RR = 0.53; 95% CI: 0.41 to 0.68; $p < 0.001$) which as similar with our study where MACE rate was 11.1% ($n=8$, death) during index hospitalization in incomplete revascularization group with HF (NYHA III-IV) as an event in one case and other three had purely electrical complication (hazard

ratio 0.062, 95%CI 0.000-0.12, $p=0.030$) but MACE rate in complete revascularization group was 0% [22]. Yousif Ahmad et al. showed that complete revascularization with PCI resulted in a significant reduction in the risk of cardiovascular death (RR, 0.68; 95% CI, 0.47–0.98; $P=0.037$) which is similar with our study findings.

Conclusion

Complete revascularization during primary index PCI definitely had better outcome than culprit only revascularization. It was associated with significant reductions in total mortality, MI, stroke, and fatal arrhythmias compared to culprit only revascularization. Contrast induced nephropathy (CIN) in complete revascularization group and culprit only revascularization group seems to be not much of difference. There was significant reduction in death or fatal arrhythmias in complete revascularization group compared to culprit only revascularization in hemodynamically stable patients thereby reducing risk of major adverse cardiac events mainly CV death and fatal arrhythmias and also by reducing repeat revascularization and hospital stay.

Study Limitations

1. This study was limited to patients attending CMCTH during the study duration who underwent CAG for acute STEMI in this hospital and found to have multi vessel disease in coronary angiogram.
2. Only the patient who gave written consent were included in the study, so not all the patient who presented during the study duration with ECG feature of STEMI and multi vessel disease in coronary angiogram were included in this study.
3. Additionally this is single centered study and the result of this study cannot be generalized, needs larger study to substantiate the findings of this study.

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