Medical Science

25(108), February, 2021

Culprit-only versus complete non-CTO revascularization during primary percutaneous intervention in acute STEMI with cardiogenic shock

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To Cite:
Abdelsalam T, Mahmoud N, Atef M, Rezq A, Elnozahi M. Culprit-only versus complete non-CTO revascularization during primary percutaneous intervention in acute STEMI with cardiogenic shock. *Medical Science*, 2021, 25(108), 461-468

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Peer-Review History
Received: 05 January 2021
Reviewed & Revised: 06/January/2021 to 16/February/2021
Accepted: 17 February 2021
Published: February 2021

Peer-review Method
External peer-review was done through double-blind method.

ABSTRACT

Background: There is marked controversy as regards the proper management approach among patients with STEMI, cardiogenic shock who show multi-vessel affection during the initial coronary angiography. A debate is present regarding culprit only versus total revascularization during the index procedure and the proper strategy needs to be re-addressed. *Aim:* This is an observational multicenter study that aims at assessing the best strategy for revascularization of STEMI patients with multivessel affection and cardiogenic shock excluding patients showing CTO lesions. *Methods:* We followed up 100 patients to either culprit-lesion-only PCI or immediate multivessel PCI. The results for the primary end point of death or renal-replacement therapy at 3 months have been reported previously. Prespecified secondary end points at 3 months included recurrent myocardial infarction, repeat revascularization, re-hospitalization for congestive heart failure, stroke, significant bleeding, the development of CIN and the amount of dye used. *Results:* As reported previously, at 3 months, the all-cause mortality was much lower the total revascularization group (32% vs. 52%, P=0.043), the need for replacement therapy was higher in the total revascularization group (10% vs. 2%, P=0.204) as well as the rates of CIN (28% vs. 9%, P=0.235). The rate of recurrent infarction was higher among the culprit-only group (10% vs 2%, P=0.204) as well as the need for urgent revascularization (18% vs. 2%, P=0.008). *Conclusion:* Among the selected groups of patients presetting with STEMI, cardiogenic shock and multi-vessel disease total revascularization provided better outcomes as regards 3-months mortality, recurrent infection and need for urgent re-intervention with no significant increment in the rates of CIN or renal replacement therapy.

Keywords: complete revascularization; culprit; STEMI; Primary PCI; cardiogenic shock

1. BACKGROUND

The mortality for AMI is aggravated by cardiogenic shock in case of prompt revascularization, including percutaneous coronary intervention. It remains as high as is 40% to 60%. In addition, as for age and gender, patients with AMI complicated by cardiogenic shock who are older than 75 years of age may have higher one-year mortality than their younger counterparts. Around 34–50% of patients with STEMI have multi-vessel coronary artery affection (Park et al., 2014). The management has been markedly controversial for culprit only versus total revascularization during the index procedure. Advocates for culprit-only revascularization argue that this strategy shortens the procedure's timing with less contrast amount and lower CIN rates. On the other hand, complete revascularization during the primary interventional procedure allows total restoration of myocardial blood supply to the hibernating myocardium, thus improving the myocardial ejection fraction. In addition, this reduces the risks obtained from access site complications, recurrent hospitalization for heart failure, myocardial infarction and improves myocardial salvage (Wald et al., 2013).

Aim of the work

To study the safety and efficacy of culprit-lesion-only percutaneous coronary intervention versus multivessel PCI among patients presenting with acute myocardial infarction and cardiogenic shock in the setting of multivessel disease excluding revascularization of lesions showing chronic total occlusion measured by the 30 days-mortality and the incidence of developed complications after the procedure.

2. METHODOLOGY

This is a cohort observational study conducted on 100 patients who presented to the emergency departments of 3 tertiary centers in Cairo for primary percutaneous coronary intervention for STEMI and multi-vessel affection associated with cardiogenic shock from the period from June 2018 till June 2019 and patients were followed for 3 months later. In the Culprit-only group all other vessel were left un-treated. In the total revascularization group all lesions > 70% in a major vessel were revascularized at the initial procedure, excluding chronic total occlusions and with a maximum amount of dye not exceeding 5ml/kg body weight.

Study population

Inclusion criteria

- AMI and cardiogenic shock
- Evidence of multivessel disease (≥2 vessels of 2 mm or larger with ≥70% stenosis)
- Planned early revascularization by means of PCI
- Identifiable culprit lesion
- Primary PCI is to be performed by an experienced operator (performing at least 200 PCI cases including at least 75 primary PCI cases per year)

Exclusion criteria

- Single vessel disease (culprit only lesion)
- The presence of a chronic total occlusion (defined as 100% occlusions with TIMI 0 flow of at least 3 months duration). (Aziz & Ramsdale, 2005)
- Resuscitation of >30 minutes
- No intrinsic cardiac activity
- Assumed neurological devastation
- Indications for primary urgent coronary artery bypass grafting (CABG)
- Mechanical cause of cardiogenic shock, or non-cardiogenic shock
- Onset of shock >12 hours before randomization
- Known severe chronic kidney disease
- Life expectancy <6 months

Study tools and procedures

All patients involved in the study were subjected to full assessment of age, sex, risk factors for coronary artery disease (smoking, hypertension, diabetes mellitus and dyslipidemia), history of CKD detected either by reduction in GFR or high serum creatinine,

history of prior percutaneous coronary intervention or coronary arteries bypass grafting, or acute coronary syndrome and pain to balloon time. Laboratory investigations including serum creatinine, and serial cardiac enzymes with cardiac troponin at initial assessment and 3 hours thereafter were done.

Full angiographic and interventional details were obtained including the number of the vessels affected, the infarct related artery, the degree of vascular occlusion, the coronary intervention that is performed, the thrombus burden before intervention, the TIMI flow before and after intervention (Chesebro et al., 1987), the application of thrombus aspiration, pre-dilatation, the fluoroscopy time, the total stent length and the angiographic results with documentation of the dye amount used.

End points

Primary end point

All-cause mortality for culprit-lesion-only vs. multivessel PCI at 3 months

Secondary end points

recurrent MI, stroke, TIMI major bleeding (Mehran et al., 2011), occurrence of mechanical cardiac complications, the development of contrast-induced nephropathy (defined as the increase in serum creatinine by a value of 0.5mg/dl above baseline or increase by 25% as compared to basal level (Andreucci et al., 2014)).

Statistical methods

The collected data was coded, tabulated, and statistically analyzed using IBM SPSS statistics (Statistical Package for Social Sciences) software version 22.0, IBM Corp., Chicago, USA, 2013. Descriptive statistics was done for quantitative data as minimum & maximum of the range as well as mean± SD (standard deviation) for quantitative normally distributed data, while it was done for qualitative data as number and percentage.

Inferential analyses were done for quantitative variables using K-S test for normality testing, independent t-test in cases of two independent groups with normally distributed data. In qualitative data, inferential analyses for independent variables were done using Chi square test for differences between proportions and Fisher's exact test for variables with small expected numbers. The level of significance was taken at P value < 0.050 is significant, otherwise is non-significant.

3. RESULTS

The characteristics of the patients at baseline and procedural characteristics, including medications at discharge, are shown in Table 1 and Table 2, respectively.

Table 1 Baseline demographic data

	Complete revascularization	Culprit only	P
Age	58.7±10.0	59.6±7.2	0.574
Male (%)	40 (80%)	37 (74%)	0.476
Smoking	36 (72.0%)	33 (66.0%)	0.517
Hypertension	25 (50.0%)	27 (54.0%)	0.689
DM	25 (50.0%)	25 (50.0%)	1.000
Hypercholesterolemia	8 (16.0%)	9 (18.0%)	0.790
Family history	6 (12.0%)	5 (10.0%)	0.749
CKD	3 (6.0%)	8 (16.0%)	0.110
PAD	2 (4.0%)	2 (4.0%)	1.000
Previous ACS	6 (12.0%)	5 (10.0%)	0.749
prior PCI	5 (10.0%)	4 (8.0%)	1.000
SBP	57.4±11.6	55.6±10.5	0.418
DBP	31.2±9.8	31.0±7.4	0.908
Creatinine (mg/dL)	1.15±0.40	1.25±0.33	0.164

DM = Diabetes mellitus; CKD = chronic kidney disease; PAD = peripheral arterial disease; ACS = acute coronary syndrome; PCI = percutaneous coronary intervention; SBP & DBP= systolic and diastolic blood pressure

Table 2 Baseline angiographic and procedural parameters

	Complete revascularization	Culprit only	P
Infarct related artery			
LAD	34 (68%)	31 (62%)	
RCA	11 (22%)	12 (24%)	0.529
LCx	3 (6%)	4 (8%)	
Others	2 (4%)	3 (6%)	
Pain to balloon (hr)	8.6±7.3	9.4±7.7	0.569
Pain to balloon (hr)	8.6±7.3	9.4±7.7	0.569
Fluoroscopy time (min)	23.2±7.3	16.6±3.4	0.001
Stent implanted/patient	2.4±0.8	1.5±1.1	0.001
Thrombus aspiration	6 (12)	10 (20)	0.275
Pre-dilatation	34 (68)	27 (54)	0.151
No-Reflow	13 (26)	15 (30)	0.656
Contrast amount (ml)	185.0±98.6	105.4±43.7	0.001
TIMI III post procedural	36 (72)	32 (64)	0.682
GP IIb/ IIIa inhibitors	17 (34)	20 (40)	0.534

LAD = left anterior descending artery; RCA = right coronary artery; LCx = left circumflex artery; GP = glycoprotein IIb/IIIa

However, there was a relatively higher fluoroscopy time in the total revascularization group vs. control group (23 vs. 16 min, P<0.001). The total amount of dye required during the index procedure was higher in the total revascularization arm but with no statistically significant value (185ml vs. 155.4ml, P=0.056).

Clinical endpoints

The primary outcome of 3-months mortality occurred in 26 patients of the culprit only revascularization arm (figure 2) and 16 patients of the total revascularization group (figure 3) (52% vs. 32%, P=0.043) as depicted in figure (1). The rates of CIN (28% vs. 18%, P=0.235) and the requirement for RRT (10% vs. 2%, P=0.204) were higher in the total revascularization group but without a statistically significant value. The rate ofpost-procedural MI (2% vs.5%, P=0.204) was higher among the culprit-only group (Table 3).

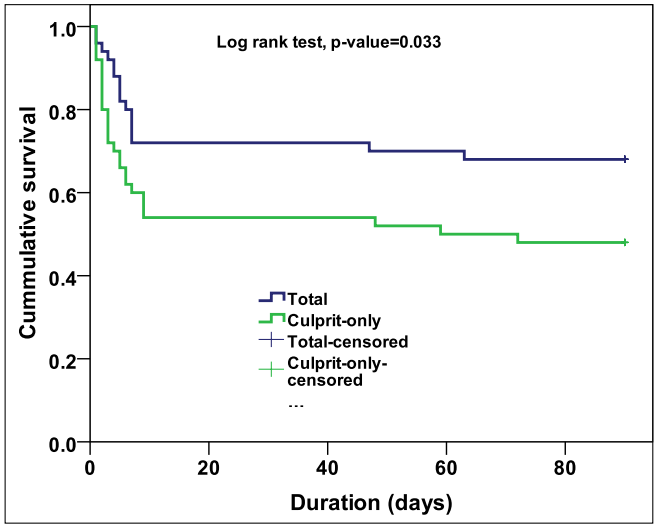

Figure 1 Kaplan Meier curve for survival among the studied groups

Table 3 Procedural details and end points

	Complete revascularization	Culprit only	P
Mortality	16 (32)	26 (52)	0.033
MI	1 (2.0%)	5 (10.0%)	0.04
Stroke	1 (2.0%)	1 (2.0%)	1.000
Mechanical complication	6 (12.0%)	4 (8.0%)	#0.505
Minor Bleeding	1 (2.0%)	2 (4.0%)	§1.000
Major Bleeding	0	0	
CIN	14 (28.0%)	9 (18.0%)	#0.235
Renal replacement therapy	5 (50.0%)	1 (2.0%)	§0.204

MI = myocardial infarction; HF= heart failure; MR = mitral regurgitation; CIN: contrast induced nephropathy

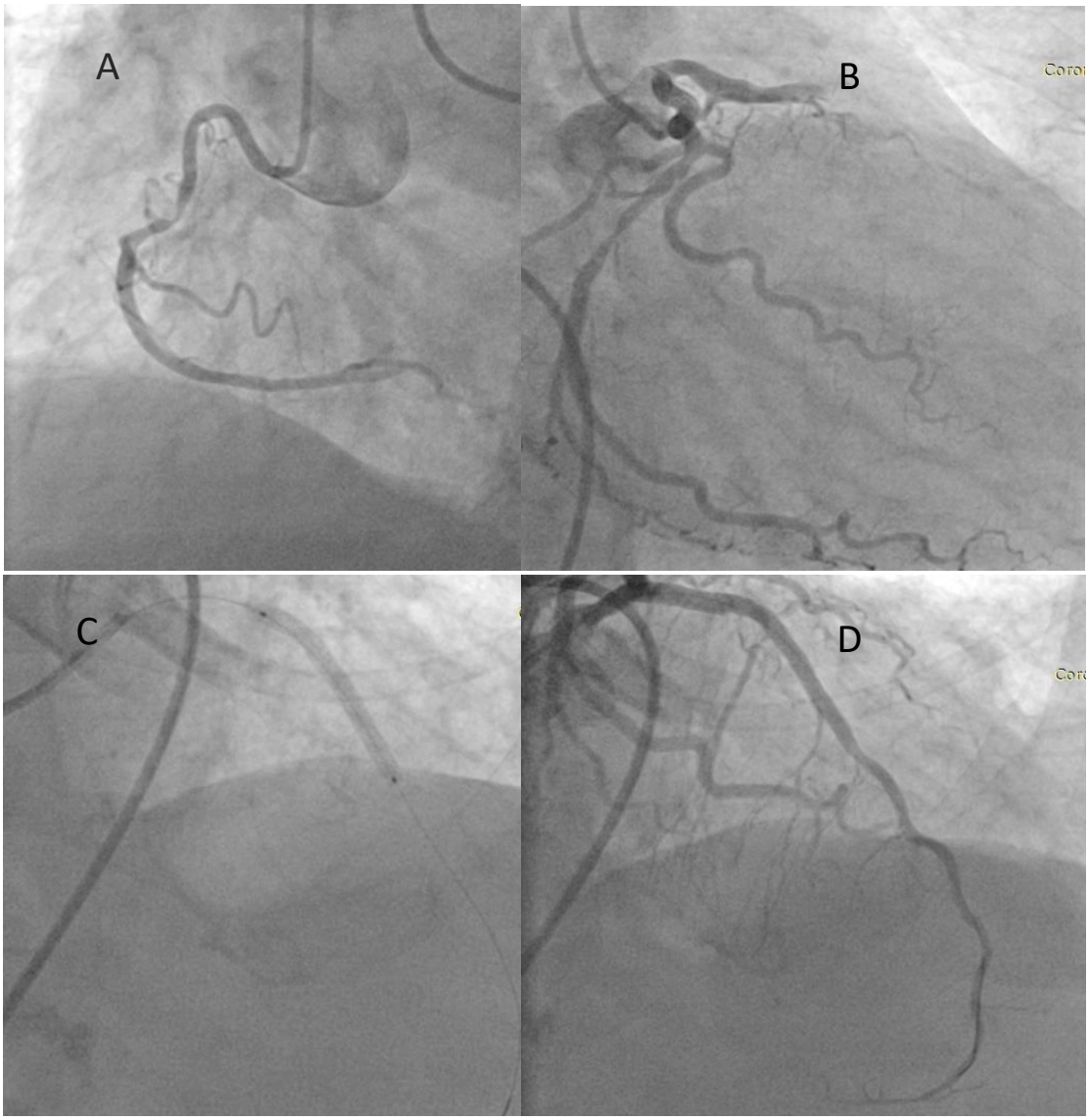

Figure 2 intervention in Culprit-only group: **(A)** RCA showing a mid tight lesion. **(B)** LAD shows a mid total occlusion, LCX showing a mid tight lesion. **(C)** stent balloon's inflation in LAD.**(D)** TIMI III flow in Lad after stent deployment.

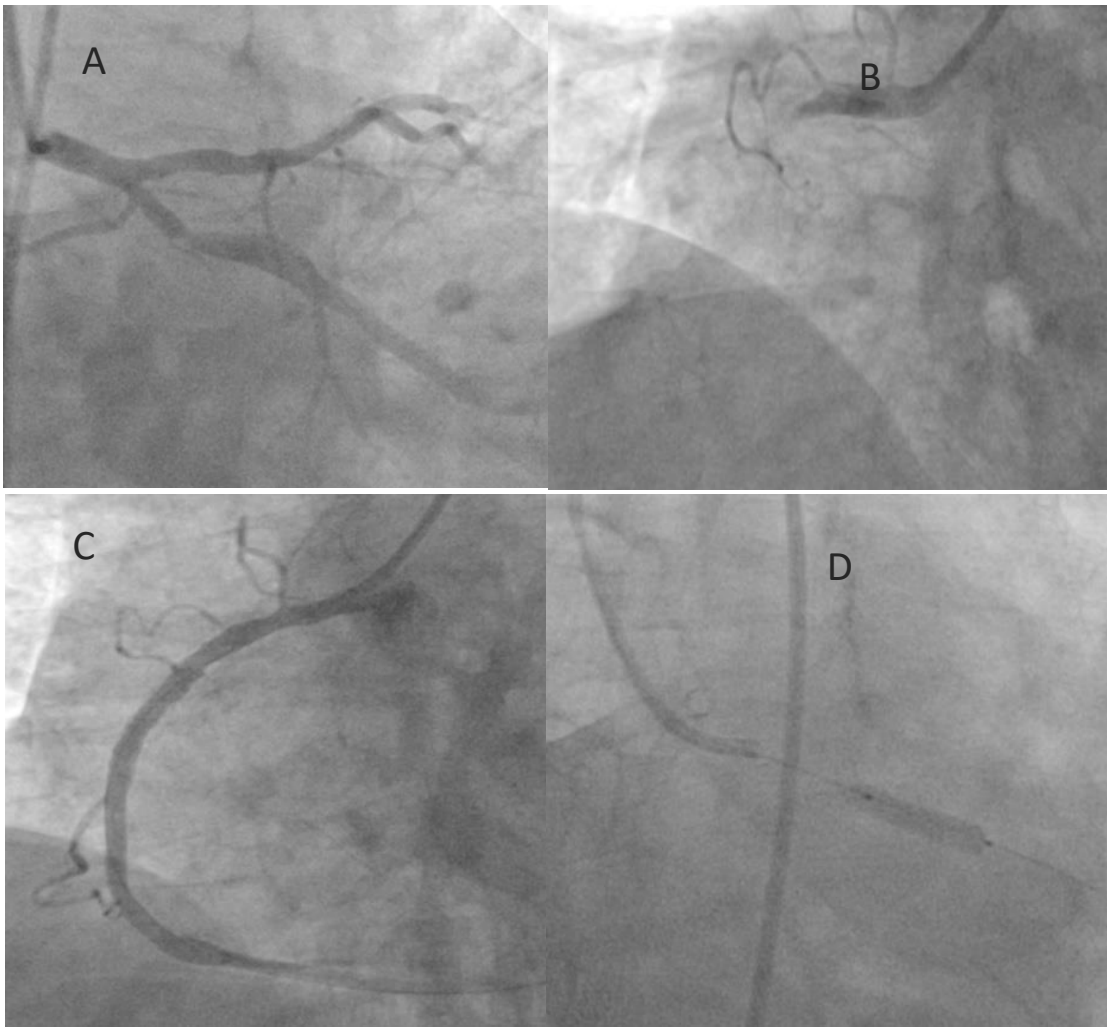

Figure 3 intervention in total revascularization group: **(A)** LCX showing a mid tight hazy lesion. **(B)** RCA shows a proximal total occlusion. **(C)** TIMI III flow in RCA after primary PCI. **(D)** stent deployment in LCX.

4. DISCUSSION

In the current study, the 3-months mortality was much higher in the culprit only revascularization arm (32% vs. 52%, P=0.043) with most of the deaths occurring within the 1st month (14 patients vs. 24 patients). Most of the deaths occurred within the in-hospital initial stay in both arms depicting that the initial period is the most critical as regards the mortality. This contradicted the findings of the Culprit-Shock trial with the mortality in the 1st year being 172 of 344 patients (50.0%) in the Culprit only group and 194 of 341 patients (56.9%) in the total revascularization group showing no significant difference among both groups (RR=0.88). where at 30 days, the primary end point of a composite of death or renal-replacement therapy had occurred in 158 of 344 patients (45.9%) in the culprit-lesion-only PCI group and in 189 of 341 patients (55.4%) in the multivessel PCI group (P = 0.01) (Thiele & Desch, 2017). This can probably be attributed to higher amount of dye resulting from the complicated nature of intervention among chronically occluded vessels resulting in a higher incidence of complications.

The Compare-Acute trial enrolled STEMI patients with multivessel coronary affection. The rate of MACCE at 1 year remained significantly lower with the complete revascularization strategy with MACCE occurring in 23 patients (7.8%) of the complete revascularization group vs. 121 patients (20.5%) in the infarct Only treatment group (P<0.001). The study excluded all chronic totally occluded vessels, however, Killip III and IV patients were excluded, as well. This provides an explanation for the matching outcome with our current study (Chin et al., 2017).

The KAMIR-NIH registry is a prospective registry that included 659 patients with STEMI, multivessel disease and cardiogenic shock. The study concluded that at 30 days follow up, the cardiac mortality was much lower in the complete revascularization group with significant statistical difference (14.3% vs. 26.1%, P=0.004). At 1 year follow up, the all-cause mortality was much less in

multivessel PCI arm (21.3% vs. 31.7%, P=0.001). Moreover, death or new RRT lower in the multivessel PCI arm were lower, as well (21.3% vs. 32.6%, P=0.001). This result was in parallel with our results in the current study (Lee et al., 2018).

Limitations

The lesion severity of the non-culprit arteries was assessed by angiographic findings solely. As shown in the DANAMI-3-PRIMULTI and COMPARE-ACUTE trials, around half of angiographically apparently significant non-IRA lesions were physiologically insignificant, with FFR values >0.8 (Chin et al., 2017; Engstrom et al., 2015). In addition, there was a relatively small sample size (100 patients) and the follow up duration was limited to 3 months.

5. CONCLUSION

Complete revascularization provided superior outcomes as regards mortality, recurrent infarctions when compared to culprit-only revascularization strategy in cases presenting with STEMI, multi-vessel affection and cardiogenic shock

Abbreviations

CTO	Chronic total occlusion
STEMI	ST elevation myocardial infarction
PCI	Percutaneous coronary intervention
AMI	Acute myocardial infarction
RRT	Renal replacement therapy
CABG	coronary artery bypasses graft
CIN	contrast-induced nephropathy
CKD	Chronic kidney disease

Acknowledgement

We thank the patients who were all participated in and contributed samples to the study. We also thank Ainshams University especially the cardiology department.

Author Contributions

TA collected, analyzed, and interpreted the data and was a major contributor to writing the manuscript. NM revised the data set. MA revised the data set. AR revised the data set. ME interpreted the patient data and was a contributor to writing the manuscript. All authors read and approved the final manuscript.

Funding

This study has not received any external funding.

Conflict of Interest

The authors declare that there are no conflicts of interests.

Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study.

Ethical approval

The study was approved by the Medical Ethics Committee of Faculty of Medicine, Ainshams University, Cairo (ethical approval code: FMASU M D 106 / 2018).

Data and materials availability

All data associated with this study are present in the paper.

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