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Infarct Related Artery only Versus Multivessel Revascularization during Primary PCI for STEMI

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Abstract

Background: Guidelines for ST Elevation Myocardial Infarction (STEMI) recommend for multivessel disease that only the culprit vessel be treated and that other diseased vessels be addressed in another time.

Methods: STEMI patients with multivessel disease undergoing primary PCIs in our center between January 2001 and April 2011 were divided into: 1- Culprit only PCI and 2- Multivessel PCI during the index procedure. Mortality rates and clinical outcomes were compared between the two groups in hospital and at 12 months.

Results: 491 patients had STEMI and multivessel disease. In 341 (69.5%) immediate multivessel PCI was performed, in 150 (30.5%) patients a culprit vessel only was treated and the rest was deferred for another procedure.

Multivessel PCI was associated with Shorter hospitalization (4.4 ± 1.27 versus 7.6 ± 2.1, P=0.01), reduced incidence of 12 months major adverse cardiac events (recurrent ischemia, reinfarction, acute heart failure and mortality (16.1 versus 35.3%, P=0.01). A significant lower rate of recurrent ischemic episodes (5.6% versus 11.3%, P=0.02), myocardial reinfarction (5% versus 10%, P=0.01), reintervention (9.4% versus 26%, P=0.01). Transient renal dysfunction was more common in multivessel PCI (8.5% versus 4% P=0.01).

In-hospital mortality (4.1% vs 4.4% p=0.9) was similar, while 1 year mortality tended to be decreased in the multivessel group (6.9% vs 7.4%), p=0.06).

Conclusion: Multivessel revascularization resulted in an improved clinical course. 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 will help us solve this dilemma.

Keywords: Multivessel revascularization; STEMI; Percutaneous coronary intervention; Killip class

Introduction

Background

Primary Percutaneous Coronary Intervention (PCI) is the recommended treatment for an acute ST Segment Elevation Myocardial Infarction (STEMI). During the index procedure the culprit artery is revascularized allowing reperfusion of the myocardium resulting in myocardial muscle salvage as well as enhanced healing of the injured tissue [1].

Patients with STEMI may present with significant angiographically proven multivessel disease in 40% to 65% of the cases [2]. For these patients, early recanalization of only the Infarct-Related Artery (IRA) by primary PCI is mandated by current guidelines [3,4]. However plaque instability may develop in a multifocal pattern resulting in multiple unstable coronary plaques in anatomically remote locations and only then to emerge as the cause of subsequent acute coronary syndrome [5].

During primary PCI most invasive cardiologists follow these guidelines and leave treatment of the other stenotic vessels for future intervention. The one caveat in the guideline recommendations is for patients in cardiogenic shock [6]. This policy intends to avoid the procedural complications that may compromise patient's condition during an acute myocardial infarction.

Currently, use of stents and platelet glycoprotein IIb/IIIa inhibitors has markedly improved outcomes of elective multivessel PCI [7,8]. Thus, only a few reports describe the results of non-culprit vessel PCI for patients undergoing mechanical reperfusion for STEMI. A small prior study of primary PCI for patients with multivessel disease demonstrated favorable results with a strategy of staged percutaneous revascularization after immediate recanalization of the culprit artery [9]. More recent reports suggest that this may be a suitable strategy for patients with acute myocardial infarction found to have multivessel disease during primary angioplasty as well [10,11]. Actually only a few small reports describe the results of simultaneous non-culprit vessel PCI and have contradictory results and it remains unclear whether treatment of coronary lesions of non-IRA is required, and if so, then when this should be performed.

In this study we report a retrospective comparison between those two approaches to primary PCI for STEMI, in order to study their influence on the short and long term outcomes, assessed by mortality, duration of hospitalization, left ventricular function, myocardial infarct extension, recurring ischemia and need for acute recatheterization.

The study hypothesizes that complete revascularization during primary PCI can be achieved safely with an improved clinical outcome during the indexed hospitalization.

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Methods

Study population

Primary PCI for STEMI was performed in 925 patients in our department between February 2001 and April 2011. Of these, 491(53%) consecutive patients admitted with STEMI had multivessel coronary artery disease.

All patients admitted to the Coronary Care Unit of the Poria Medical Center with the diagnosis of STEMI were included. STEMI was defined as prolonged (more than 30 minutes) ischemic chest pain, whose onset occurred less than 12 hours prior to hospital admission, with an electrocardiogram demonstrating an ST elevation of at least 1 mm in two or more limb electrocardiographic leads or 2 mm in two or more contiguous precordial leads. Written informed consent for performing primary PCI was obtained from all patients.

Excluded from this study were patients presenting in cardiogenic shock and the presence of left main stenosis of 50% or more. All patients were treated by aspirin, clopidogrel or prasugrel, intravenous heparin, nitroglycerin, tirofiban, eptifibatide or bivalurdin unless contraindicated.

Routine transthoracic echocardiography was performed before, following PCI and before discharge. Patients underwent routine coronary angiography in a dedicated procedure room inside the coronary care unit using Cardiac OEC, Series 9800, C Arm digital system. The presumed non infarct related vessel was first angiographically demonstrated using a diagnostic catheter. Subsequently the infarct related artery was engaged with an angioplasty guiding catheter.

All patients underwent PCI of the culprit artery and at the discretion of the operator this was followed by complete revascularization for the other stenosic arteries or conservative management with intent to complete the revascularization at later date.

A retrospective analysis of the hospitalization course was performed looking at the outcome of the following two groups:

1. Complete revascularization (CR): This group comprises 341(69.5%) patients with STEMI in whom the infarct related artery was treated and followed by PCI of the other significantly narrowed arteries.
2. Culprit only revascularization (COR): This group comprises 150 (30.5%) patients with STEMI in whom the infarct related artery only was dilated and the other stenosic vessels were left untreated during the primary PCI.

Clinical assessment

The patient's data and hospital reports were reviewed to record clinical variables including age, sex, smoking practice, diabetes mellitus, hypertension and hypercholesterolemia.

Information was obtained regarding the initial revascularization strategy, recurrent acute ischemic events including unstable angina [prolonged (>20 minutes) angina at rest; new onset of severe angina; angina that is increasing in frequency, longer in duration, or lower in threshold; or angina that occurs after a recent episode of MI, is defined by the absence of biochemical markers] and myocardial infarction, recatheterization, repeated revascularization, hospitalization duration, development of acute heart failure diagnosed as pulmonary crackles or S3 gallop or persistent pulmonary congestion in chest X-ray and in-hospital mortality.

Major bleeding was defined as either intracranial haemorrhage or bleeding that causes haemodynamic compromise and requires intervention or that needed blood transfusion of two or more of packed blood cells.

Transient renal dysfunction was defined as a rise of 30% and more in plasma creatinine value within 24 hours from the baseline.

Statistics

Chi-square tests for categorical data were applied for the comparison between groups, and the Fisher exact test when cell expected frequencies were low. Culprite vs complete continuous data were compared by the paired t-test and ANOVA was used for the comparison between groups. P-values were adjusted for multiple comparisons. Kaplan-Meier curves were constructed for MACE data and compared by the log rank tests. All P values were 2 sides. Statistical analysis was performed with the software SAS (version 9.2).

Results

Table 1 illustrate that the baseline clinical characteristics were comparable among the two groups. There were no differences in infarct site and Killip class at presentation between the two groups (Table 2). The myocardial infarction location by electrocardiogram of the whole cohort was distributed as follows: 252 (51.3%) patients presented with an anterior wall myocardial infarction, 146 (29.7%) patients presented with an inferior wall and 93 (19%) with posterolateral MI. Killip class presentation was I=61%, II=22%, III=17%.

Double vessel disease (>70%) was present in 255 (51.9%) patients, triple vessel disease occurred in 236 (48.1%) patients. The epicardial perfusion before PCI was distributed as follows: TIMI flow 0–1 in 344 (70%) patients, TIMI flow 2 in 70 (14.2%) patients and TIMI 3 in 77 (15.8%) patients. There was no difference in the angioplastic results graphic findings between the two groups (Table 3). A successful angioplastic result (residual stenosis less than 30%) was achieved in 148 (98.7%) of COR group, compared with 334 (98%) in the CR group (Table 4).

	CR(n=341)	COR(n=150)	P value
Male	64%	61%	0.91
Mean age	66 ± 3	67 ± 4	0.84
Previous CABG	11%	10%	0.93
Previous PCI	17.6%	17.3%	0.96
Prior MI	25%	27%	0.91
Smoker	61%	57.5%	0.86
Hypertension	37.8%	38.5%	0.83
Hyperlipidemia	14.6%	15.4%	0.81
Diabetes	12.3%	15.4%	0.71

CR: Complete revascularization; COR: Culprit only revascularization

Table 1: Baseline clinical characteristics of the patients.

	CR(n=341)	COR(n=150)	P value
Infarct Site			
Anterior	175 (51.3%)	77 (51.3%)	0.16
Inferior	105 (30.8%)	41 (27.3%)	0.78
Posteolateral	25%	32 (21.4%)	0.80
Killip Class			
I	280 (61%)	92 (60%)	0.96
II	75 (22%)	33 (23.3%)	0.86
III	58 (17%)	25 (16.7%)	0.78

Table 2: Infarct site and patients clinical presentation.

	CR(n=341)	COR(n=150)	P value
Infarct related artery			
LAD	50.2%	52%	0.65
RCA	30.2%	28.6%	0.72
CX	18.5%	18.1%	0.85
Graft	1.1%	1.3%	0.92
Non culprit vessel stenosis			
LAD	43.9%	42.3%	0.88
RCA	29.3%	29.3%	0.83
CX	25.7%	26.1%	0.94
Graft	1.1%	1.3%	0.90
IABP	13.7%	11.5%	0.14
PCI of IRA			
Stenting	93.8%	93.3%	0.79
POBA	5%	6.1%	0.31
Unsuccessful	1.2%	0.6%	0.14

Table 3: Angiographic and procedural characteristics.

	Complete (341)	Culprit(150)	P value
PCI results			
Successful PCI	334 pts (98%)	148pts (98.6%)	0.86
TIMI 3 flows	293 pts (86%)	127 (85%)	0.65
Complete Revascularization Drawbacks			
Procedure time (minutes)	83 ± 27	40 ± 15	0.01
Transient renal dysfunction	29 (8.5%)	6 (4%)	0.01
Major bleeding	8 (2.4%)	2 (1.3%)	0.08

Table 4: PCI results and complete revascularization drawbacks.

The choice not to complete revascularization in the COR group was due to one of the following reasons:

1- Operator's decision to continue with staged percutaneous interventions for lesions in arteries other than the culprit infarct-related artery in 90 (60%) patients.

2. The necessity to terminate the procedure because another patient arrived with an acute MI in 36 patients (24%).

3. The procedure was lengthy and complex requiring a large quantity of contrast in 24 (16%) patients.

The clinical and echocardiographic characteristics of the two groups are given in Table 5. Complete Revascularization (CR) was associated with reduced incidence of major adverse cardiac events (recurrent ischemia, re-infarction, acute heart failure and in-hospital death 16.1% versus 35.3%, P=0.01). The rate of recurrent ischemic episodes, myocardial re-infarction, re-intervention during the index hospitalization and presence of acute heart failure in the complete revascularization group was significantly less than COR group.

Duration of hospital stay was lengthier in the COR group (7.6 ± 2.1 versus 4.45 ± 1.27 days, P=0.01). Acute left heart failure manifesting as pulmonary crackles, S3 gallop or persistent congestion on chest x-ray was observed in 21(14%) patients in COR group compared to 19 (5.6%) in the CR group (p=0.01). 15% of CR patients showed improvement of wall motion in LV region supplied by the non-infarct related artery versus none of the COR patients. The incidence of improvement in the infarct artery related LV territory was similar (40% versus 33% respectively, P=0.07).

In-hospital mortality was similarly low in both groups (4.1% and 4% for CR and COR respectively, P=0.9), while 1 year mortality tended to be decreased in the CR group (6.9% and 7.4% respectively, P=0.06) (Figure 1).

The disadvantages of complete revascularization were transient renal dysfunction (defined as a rise of 30% or more in plasma creatinine level within 24 hours from the baseline) was higher in the CR group (8.5% versus 4%; P=0.01), procedure time was longer in the CR than COR group (83 ± 27 versus 40 ± 15 minutes; P=0.01) and there was an increased trend major bleeding in the COR group (2.4% versus 1.3%; P=0.08) (Table 4).

By univariate analysis, the type of PCI (COR vs CR) (P=0.003), anterior wall MI, diabetes mellitus (P=0.048), baseline renal dysfunction (P=0.028), Killip classification on arrival=3 (P=0.04) were recognized to be associated with in-hospital MACE (Table 6). Variables that were statistically significant in the univariate analysis or clinically important

	Complete (n=341)	Culprit (n=150)	P value
In hospital reinfarction	17 (5%)	15 (10%)	0.01
Recurrent ischemia	19 (5.6%)	17 (11.3%)	0.02
Acute heart failure	19 (5.6%)	21 (14%)	0.01
In hospital MACE	55 (16.1%)	53 (35.3%)	0.01
Length of hospitalization	4.45 ± 1.27	7.6 ± 2.1	0.01
Culprit segment wall motion improvement	40% (104/260)	33% (37/112)	0.07
Non- segment wall motion improvement	15% (39/260)	0%	0.01
In hospital mortality	4.1% (14/31)	4% (6/150)	0.9

Table 5: In hospital MACE (reinforcement, recurrent ischemia, acute heart failure, intervention) and mortality.

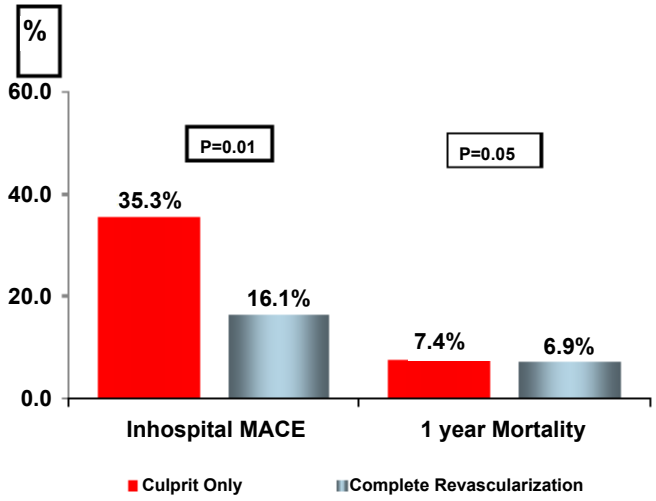

Figure 1: Multi-vessel PCI is feasible and safe, associated with improved in hospital outcome.

	HR	CI 95%	P value
Culprit only	1		
Complete vs culprit	0.45	0.3-0.8	0.003
Diabetes	1.8	1.4-2.3	0.04
Hypertension	0.95	0.9-1.08	0.73
LVEF before PCI<40%	1.1	0.95-1.2	0.84
Killip class	1.8	1.5-2.9	0.04
Anterior MI	3.2	2.2-4.5	0.03
TIMI flow 3 before PCI	0.8	0.72-0.94	0.03
Baseline RD	1.9	1.7-2.3	0.03
Improvement in WMA in culprit territory	0.2	0.15-0.3	0.02

Table 6: Predictor of in hospital MACE- univariate model.

were included in the multivariate analysis model. The independent predictors of in-hospital MACE were culprit only revascularization {odds ratio (OR) =1.468, confidence interval (CI) (95%) (1.12-3.03), P=0.001}, renal failure on admission {OR=1.98, CI (95%) (1.31–2.93), P=0.029}, and an anterior wall MI {OR=5.2, CI (95%) (1.2–21.07), P=0.027}. Improvement of wall motion contraction in the culprit territory was closely associated with better outcome {OR=0.2, CI (95%) (0.04–0.89), P=0.035} (Table 7).

Discussion

During the early days of PCI the procedure was limited to a solitary lesion in a single vessel. With time, greater experience, skills, expertise and techniques enable more reliable, predictable and reproducible results. Today, triple vessel multilesion multivessel interventions are common practice in many laboratories for both chronic stable and acute unstable coronary syndromes [12]. Performing PCI in the same setting (even at the time of myocardial infarction) limits vascular access and anticoagulant-related bleeding complications arising from the subsequent procedures, as well as reducing costs [9].

Presently, limiting of angioplasty to the infarct related artery only is the guideline recommendation for primary PCI during acute STEMI uncomplicated by cardiogenic shock. This recommendation is due to lack of evidence to the contrary policy as well as concerns related to the specific clinical situation. Issues such as unnecessary treatment of self-resolving lesions and further destabilization of an already unstable condition have been raised [10,13].

Indeed, unstable plaques may spontaneously resolve but they may also rapidly progress and complicate recovery from STEMI [14-16]. Perhaps a lesson should be learned from the non-STEMI field where the recommendation to defer intervention has been weave off by the results of the ISAAR COOL study [17]. In another recently published data patients with coronary artery disease without STEMI do not have significantly lower long term mortality rates with staged PCI than when they undergo complete revascularization in the index admission [18].

Retrospective reports are contradictory in their results and recommendations. Reports from Roe, Corpus, Kornovski and Vlaar describe a deleterious effect of multivessel PCI during STEMI and recommend culprit vessel treatment only [19-22]. Other studies by Di Mario and Sethi found equal results between the two strategies however they still recommend culprit only revascularization during primary PCI [22,23].

The present study shows that multivessel vessel angioplasty is safe and feasible with a high success and low complication rate even in the circumstances of primary PCI for STEMI. This conclusion is in accordance with the Italian study reported by Politi, the Polish experience described by Zbigniew, the AMIS national registry from Switzerland, our center initial study published previously by Qarawani and the multi-center randomized study (PRAMI) published recently [19,25-28].

The disadvantages of multivessel PCI were longer procedure times and an increased rate of transient renal dysfunction (most likely related to increased amount of contrast used). Nonetheless, we have observed a better clinical course marked by considerably lower MACE rate in the patients who underwent complete revascularization.

	HR	CI 95%	P value
Culprit artery only	1.468	1.12-3.03	0.001
Baseline renal failure	1.98	1.31-2.93	0.029
Anterior wall MI	3.2	2.8-5.6	0.027
Improvement of wall motion in culprit territory	0.2	0.04-0.89	0.035

Table 7: Independent predictor of in hospital MACE –multivariate model.

Patients who underwent revascularization only of the culprit artery had a more complicated in-hospital course. They had higher incidences of recurrent ischemia, myocardial reinfarction, more episodes of acute left heart failure and longer hospital stay. They were more likely to require repeated reintervention, directed to the noninfarct- related plaques that were left untreated at the first procedure. The lower nadir hemoglobin and increased need for blood transfusions are probably related to increased blood loss associated with high rate of repeated in hospital reintervention in the culprit only revascularization group.

PCI stabilization of unstable non culprit plaques with significant luminal narrowing may explain the reduced incidence of post-MI ischemic episodes.

The improved function of LV regions remote from the infarcted territory (observed following complete revascularization) explains the reduced incidences of heart failure episodes. The differences in-hospital course was translated to a tendency to lower mortality rate in the group of complete revascularization.

Limitations

The present study is retrospective and non-randomized. The difference between the groups was driven by a significantly higher MACE rate in the culprit only revascularization. This can partly be explained by the cohort‘s baseline characteristics with multiplicity of risk factors, and 30% previous revascularization and MI episodes. Moreover, our patients are monitored in an intermediate care setting throughout their hospital stay. Furthermore, selection bias may have taken place in this retrospective study, prolonged and difficult recanalization of the culprit artery (which was one of the reasons not to perform non-culprit revascularization) may indicate more severe coronary pathology and patient‘s discomfort during the procedure leading the operator to end the procedure may be related to an unstable cardiac status heralding a more complicated clinical course.

Nevertheless, safety profile and potential benefit of complete revascularization during primary PCI for STEMI shown in this report are worth further validation in larger multi-center randomized study.

Conclusion

The present study report pertains to the feasibility and safety of performing multivessel PCI in the setting of ST elevation myocardial infarction. The advantage of this approach is that it may improve in-hospital outcomes, the disadvantage is a prolonged time consuming procedure accompanied by increased risk of renal dysfunction. Decisions about PCI of the non-infarct vessel(s) should be individualized. We suggest that a prospective large multicenter randomized trial should check the hypothesis that this study has generated, meanwhile the decision to perform multivessel revascularizaion during primary PCI should be left to the operator’s discretion in this emergent condition.

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