

*Research Article***Different revascularization strategies in ST-elevation myocardial infarction (STEMI)****Ashraf R. Mohammed Atta, Alaa M. Ibrahim, Hesham B. Mahmoud, Tarek M. Abdelrahman, Hany T. Taha**

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Abstract

Effective and in time reperfusion of the infarct-related coronary artery is essential to optimal treatment for ST-elevation myocardial infarction (STEMI). Now it is established the benefit of primary percutaneous intervention (PPCI) in STEMI over fibrinolysis. While intervention of the non-infarct related artery still a large area of debate with no definite consensus. Here in this review we will highlight the different reperfusion strategies and different ways to reach optimal reperfusion and debate about non-IRA in different situations.

Key Words: STEMI, Revascularization, PCI**Introduction**

Effective and in time reperfusion of the infarct-related coronary artery is essential to optimal treatment for acute coronary syndrome (ACS). In comparison with fibrinolysis, primary percutaneous coronary intervention (PCI) establishes more consistent and predictable epicardial artery recanalization, significantly lowers the risk of intracranial hemorrhage and stroke, reduces recurrent ischemia and reinfarction, and improves survival^(1,2).

Early angiography followed by revascularization when appropriate also improves clinical outcomes with the greatest benefits realized in the highest risk patients. Because epicardial artery reperfusion does not guarantee myocardial perfusion, strategies for cardioprotection and optimization of tissue level reperfusion are also essential⁽³⁾.

Here we will highlight different reperfusion strategies to achieve faster and more effective epicardial vessel and microvascular reperfusion in patients with STEMI as well as temporal and logistic factors that may affect treatment outcomes.

Reperfusion in STEMI

Early reperfusion therapy is the most important issue in the management of STEMI. The greatest amount of infarction occurs in the first few hours after coronary occlusion⁽⁴⁾. A recent

analysis of 12 675 STEMI patients in the FITT-STEMI trial confirmed the strong impact of time delays on mortality, particularly in STEMI patients with cardiogenic shock or out-of-hospital cardiac arrest⁽⁵⁾

Given this association between shorter time to reperfusion and survival, Door to Ballone(D2B) time became the focus of regional) and national quality improvement initiatives.^(6,7) Several strategies were developed, tested, and formally incorporated into clinical guidelines to shorten D2B times.⁽⁸⁾ By using such evidence-based strategies, there have been significant improvements in D2B times across the country and across different types of hospitals.⁽⁹⁾ However, Menees et al.,⁽¹⁰⁾ showed that despite continuing reductions in national D2B times (from median 83 to 67 minutes), in-hospital mortality rates have remained unchanged, although adjustment for change in cardiac arrest was not possible. Possible explanations include reductions in D2B time that are too small to reduce infarct size or initiation of treatment that is too late or follow-up that is too short to show improvement in survival. D2B time is only one component of total ischemic time, and because D2B time is reduced, delays to hospital presentation become a relatively larger fraction of reperfusion delay. This observation also emphasizes that other components of the reperfusion process must be improved (eg, more effective myocardial

reperfusion, reduction in reperfusion injury) to enhance outcomes in STEMI further.⁽⁶⁾

Which Reperfusion Method:

Primary PCI, defined as percutaneous catheter intervention in the setting of STEMI without previous fibrinolysis, is the preferred reperfusion strategy. It has replaced fibrinolysis in patients with STEMI, provided it can be performed in a timely manner in high-volume PCI centers with experienced operators and 24 h/7 days week catheterization laboratory activation⁽¹¹⁾.

In settings where primary PCI cannot be performed in a timely fashion, fibrinolysis should be administered as soon as possible. If first medical contact (FMC) is out-of-hospital, lysis should be implemented pre-hospital (e.g. in the ambulance)⁽¹²⁾.

It should be followed by transfer to PCI-capable centers for routine coronary angiography in all patients, and should be performed without delay for rescue PCI in the case of unsuccessful fibrinolysis or within 2–24h after bolus administration.⁽¹¹⁾

Pinto et al.,⁽¹³⁾ reported from a propensity-matched observational analysis of >19 000 patients with STEMI that the mortality advantage of primary PCI compared with fibrinolysis seemed to be lost when PCI-related delay exceeded 121 minutes. Based on these data, ACCF/AHA guidelines for STEMI were released⁽⁸⁾. Fibrinolytic therapy, in the absence of contraindications to its use, should in general be administered within 30 minutes of hospital arrival in patients with STEMI at non-PCI capable hospitals when the anticipated FMC-to-device time at a PCI-capable hospital is >120 minutes.⁽¹⁴⁾

Primary PCI

Primary PCI is the preferred reperfusion strategy if a skilled interventional cardiologist and catheterization laboratory is available and if the procedure can be performed within 90 minutes after initial medical contact with the patient.⁽⁶⁾

The TRANSFER-AMI study further tested the pharmacoinvasive strategy concept in high-risk STEMI patients. Patients who had at least 1

high-risk feature [greater than or equal to 2 mm of ST-segment elevation in 2 anterior leads, systolic blood pressure less than 100 mm Hg, heart rate higher than 100 bpm, Killip class II to III, 2 mm or more of ST-segment depression in the anterior leads, or 1 mm or more of ST elevation in right-sided lead V4 indicative of right ventricular involvement for inferior MIs]⁽¹⁵⁾

Selection of size and type of stents:

The use of DES to prevent restenosis and target vessel revascularization rates in high-risk patients [i.e., patients with diabetes] and in high-risk lesions [longer and smaller diameter stents] could be recommended due to decrease of target vessel revascularization but no difference in the 12-month composite safety end point of death, reinfarction, stroke, or stent thrombosis⁽¹⁰⁾

New generation DES has higher efficacy and safety in comparison with both early-generation DES and BMS⁽¹⁶⁾. Although stenting with new generation DES confers a similar risk of death or MI at mid- to longterm follow-up in comparison with BMS, the risk of subacute and late stent thrombosis is significantly lower.⁽¹⁷⁾

Moreover, the risk of very late stent thrombosis is at least comparable to that of BMS and lower than that of early-generation DES. These observations were confirmed in a recent trial enrolling patients aged 75 years or older and demonstrating superior outcomes (composite of all-cause mortality, MI, stroke, or ischaemia-driven target lesion revascularization) with DES as compared with BMS with similar duration of intended DAPT (1m month or 6 months) in both treatment arms.⁽¹⁸⁾ So last ESC revascularization guidelines recommended new generation DES should be considered as the default stent type for PCI regardless of clinical presentation, lesion subtype, concomitant therapies, or comorbidities.⁽¹⁹⁾

The safety and efficacy profile of the Absorb BVS has been compared with contemporary DES in several trials. Findings of these trials as well as meta-analyses consistently indicate the inferior efficacy and safety of Absorb BVS compared with contemporary DES during long-term follow-up. Specifically, the Absorb BVS is associated with a significantly increased risk of target lesion revascularization and device

thrombosis, with numbers needed to harm of 40–60. Of note, commercial use of the Absorb BVS was stopped in 2017.⁽²⁰⁾

Management of Non-infarct Stenosis during Primary PCI:

Multi-vessel disease is seen in up to 60% of patients presenting with STEMI and has a worse prognosis compared with patients with STEMI with single-vessel disease.⁽²¹⁾

Previous observational and nonrandomized studies and metaanalyses supporting the strategy of IRA-only PPCI recommended by the 2013 AHA/ACC guidelines⁽²²⁾.

However, then emerging data suggested that PCI of non-IRA in patients with STEMI may be superior to the standard approach of IRA-only PCI. As a result, a focused update on primary PCI was published in 2015 by the ACC/AHA, suggesting that PCI of non-IRAs may be considered in select patients⁽²³⁾.

Four major randomized trials—**PRAMI** (Preventive Angioplasty in Acute Myocardial Infarction), **CvLPRIT** (Complete Versus Lesion Only Primary PCI trial),⁽²⁴⁾ **DANAMI-3-PRIMULTI** (The Third DANish Study of Optimal Acute Treatment of Patients with STsegment Elevation Myocardial Infarction: PRImary PCI in MULTi vessel Disease), and **Compare-Acute** have consistently shown a benefit of complete revascularization (performed immediately or staged) as compared with IRA-only PCI in patients with STEMI and multivessel disease⁽²⁵⁾

While in another meta analysis by Elgendy et al., showed that the risk of all-cause mortality and spontaneous reinfarction is not different among the various revascularization strategies for multivessel disease. Complete revascularization at the index procedure or as a staged

procedure (either during the hospitalization or after discharge) was associated with a reduction of MACE due to reduction in urgent revascularization with no difference between these 3 strategies.⁽²⁶⁾

Functional Assessment of Non-Ira Lesions

Recently DANAMI- 3-PRIMULTI trial studied the clinical outcomes by comparing the fractional flow reserve (FFR) guided by complete revascularization with IRA-only PCI in STEMI, and found that the composite rate of all-cause mortality, nonfatal reinfarction, and repeat revascularization was significantly lower in the complete revascularization group, which was mainly driven by a reduction in repeat revascularization and More recently, another randomized trial (COMPAREACUTE) revealed that FFR-guided complete revascularization of non-IRA arteries in an acute setting was associated with a lower risk of the composite cardiovascular outcome⁽²⁵⁾.

So, updated ACC/AHA guidelines recommended that complete revascularization can be considered either at the time of primary PCI or after the index procedure as a staged procedure. The 2017 European Society of Cardiology guidelines recommended a class IIa recommendation for complete revascularization STEMI patients with MVD.⁽¹¹⁾

Recently, the results of COMPLETE trial were released. At a median of three years, complete revascularization reduced the risk of the composite of cardiovascular mortality or MI (HR = 0.74, 95% CI: 0.60–0.91, P = 0.0004) driven by a reduction in the risk of MI (HR = 0.68, 95% CI: 0.53–0.86). Complete revascularization also reduced the risk of the composite of cardiovascular mortality, MI or ischemia-driven revascularization (HR = 0.51, 95% CI: 0.43–0.61, P < 0.0001). ± 2.7).⁽²⁷⁾

Table (1) Characteristics of the major trials comparing complete revascularization with IRA only revascularization

Trial	Year	N	Complete revascularization approach	Major adverse cardiac events	All-cause mortality	Re-infarction	Urgent revascularization
PRAMI	2013	234/231	Index	21/53	12/16	7/20	16/46
CvLPRIT	2015	150/146	Index (67%), staged prior to hospital discharge (33%)	15/31	2/6	0/2	7/12
DANAMI-3-PRIMULTI	2015	314/313	Staged 2 days after index PCI	40/68	15/11	15/16	17/52
COMPARE-ACUTE	2017	295/590	Index (83%), staged prior to hospital discharge (17%)	23/121	4/10	7/28	18/103
COMPLETE https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6790959/ - b35	2019	2016/2025	Staged: 64% prior to discharge (median 1 day), 36% after discharge (median 23 days)	179/339	96/106	109/160	29/160

Management of Non-IRA in the setting of cardiogenic shock:

Cardiogenic shock (CS) in the setting of acute myocardial infarction (AMI) is associated with significant morbidity and mortality.⁽¹¹⁾

For the treatment of patients with multi-vessel disease, current European guidelines for the management of acute ST-segment elevation myocardial infarction recommend immediate percutaneous coronary intervention (PCI) of both culprit and non-culprit lesions⁽¹¹⁾

However, the 30-day results of the Culprit Lesion Only PCI versus Multi-vessel PCI in Cardiogenic Shock (CULPRIT-SHOCK) trial⁽²⁸⁾ showed that the risk of a composite of death from any cause or severe renal failure leading to renal-replacement therapy was lower with culprit lesion- only PCI than with immediate multi-vessel PCI, thus challenging the guideline

recommendations. On the basis of these results, the European revascularization guidelines have now downgraded immediate multi-vessel PCI in cardiogenic shock to a class III B recommendation (i.e., a recommendation that the procedure is not useful and may be harmful, according to evidence from a single randomized trial⁽¹⁹⁾).

In light of the short-term results of the CULPRITSHOCK trial, the use of multi-vessel PCI in patients with cardiogenic shock is now controversial.⁽¹¹⁾

**Strategies to Shorten Time to Reperfusion:
Reducing Patient-Related Delays:**

Patients with STEMI do not seek medical care for ≈1.5 to 2 hours after symptom onset, and there has been little change in this interval during the past 10 years.⁽²⁹⁾

Patient delays are longer in women, blacks, Medicaid-only recipients, and especially the elderly.⁽²⁹⁾ Such delays may be avoided by making anticipatory plans for timely recognition and response to an acute event. Several studies have also demonstrated a significant association between arrival to hospital by ambulance and earlier delivery of reperfusion therapy.⁽³⁰⁾

Reducing Health System–Related Delays:

Efficient reperfusion in STEMI requires multidisciplinary co-ordination between the various points of medical care. These considerations fueled the evolution of systems and centers of care for patients with STEMI. In 2007, the AHA launched Mission: Lifeline, a community-based initiative to improve STEMI systems of care; and in 2009, the ACCF/AHA supported this approach with a class I recommendation consistent with the European guidelines.⁽³¹⁾

Prehospital ECG and Catheterization Laboratory Activation In a report from the National Cardiovascular Data Registry, only one quarter of patients with STEMI transported by emergency medical service received a prehospital ECG, with use of a prehospital ECG associated with accelerated diagnosis and activation of the PCI-capable center, greater use of reperfusion therapy, faster reperfusion times, and a trend toward lower mortality.⁽³²⁾

Bypassing Non–PCI-Capable Hospitals:

Bypassing geographically closer hospitals without primary PCI capabilities has been associated with faster reperfusion times and ~3-fold greater likelihood of achieving target guideline of <90 minutes from FMC to PCI. This strategy has been implemented successfully in other countries and has been proposed as one means of achieving more rapid reperfusion in STEMI.⁽²³⁾

Bypassing PCI-Capable Hospital ED

To optimize timely reperfusion, the 2012 European Society of Cardiology STEMI guidelines recommend bypassing the PCI-capable hospital ED by transporting patients identified with STEMI on a prehospital ECG directly from the field to the cardiac catheterization laboratory.⁽²³⁾ However, the updated ACCF/AHA STEMI guidelines have not yet

promoted this strategy.⁽⁸⁾

Conclusion

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