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REVIEW TOPIC OF THE WEEK

PCI Strategies in Patients With ST-Segment Elevation Myocardial Infarction and Multivessel Coronary Artery Disease

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ABSTRACT

Recent randomized controlled trials have suggested that patients with ST-segment elevation myocardial infarction and multivessel coronary artery disease may benefit more from multivessel percutaneous coronary intervention (PCI) compared with culprit vessel-only primary PCI. The American College of Cardiology, American Heart Association, and Society for Cardiovascular Angiography and Interventions recently published an updated recommendation on this topic. The purpose of this State-of-the-Art Review is to accurately document existing published reports, describe their limitations, and establish a base for future studies. (J Am Coll Cardiol 2016;68:1066–81)
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Approximately 50% of patients with ST-segment elevation myocardial infarction (STEMI) have multivessel (MV) coronary artery disease (CAD) (1). The short-term prognosis after STEMI is worse with MV CAD than with single-vessel CAD (2–4), perhaps because of additional plaque instability (5,6); impaired myocardial perfusion caused by endothelial dysfunction, microvascular spasm, or inflammation (7); or decreased contractility in noninfarct zones (2,8). The long-term prognosis is also worse because of older age, more atherosclerotic risk factors, higher atherosclerotic disease burden, and lower left ventricular ejection fraction in patients with MV CAD (9).

The 2011 American College of Cardiology Foundation (ACCF)/American Heart Association (AHA)/Society for Cardiac Angiography and Interventions (SCAI) guideline for percutaneous coronary intervention (PCI) and the 2013 ACCF/AHA guideline for STEMI recommended that primary PCI should not be performed (Class III, Harm) in a noninfarct artery in patients with STEMI who are hemodynamically stable (10,11). Additionally, the American College of Cardiology (ACC) Appropriate Use Criteria Task Force labeled PCI of a noninfarct artery at the time of primary PCI as "inappropriate" (12). These recommendations arose from historical safety concerns that included an increased potential for procedural complications, contrast nephropathy, and stent thrombosis. However, more complete acute revascularization in patients with STEMI may be safer in the current era due to advances in stent technology and antiplatelet therapy; might decrease mortality, reinfarction, and repeat revascularization rates; and

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could reduce hospital length of stay, resource utilization, and cost. In fact, several recent randomized controlled trials and meta-analyses have supported this strategy (see later discussion). In response to these reports, the ACC removed the 2012 proscription against MV primary PCI from the American Board of Internal Medicine Foundation Choosing Wisely Campaign in 2014 (13). Additionally, the 2014 European Society of Cardiology (ESC)/European Association for Cardio-Thoracic Surgery (EACTS) Guidelines on Myocardial Revascularization and the 2015 ACC/AHA/SCAI Focused Update on Primary PCI committee assigned a new Class IIb recommendation, concluding that MV primary PCI may be considered in selected hemodynamically stable patients with significant noninfarct artery stenoses (14,15).

Nevertheless, the best strategy for the treatment of the noninfarct artery in patients with STEMI and MV CAD remains an unresolved issue, with important implications for potentially improving clinical outcomes in these patients. PCI strategies include: 1) culprit vessel-only (CVO) primary PCI with continued medical management and PCI of noninfarct arteries only for spontaneous angina or myocardial ischemia on stress testing; 2) MV PCI at the time of primary PCI; or 3) CVO primary PCI, followed by staged PCI of noninfarct arteries later during the index hospitalization or soon after hospital discharge (**Central Illustration**). This review summarizes the data on PCI for patients with STEMI and MV CAD (15).

The terms *preventive angioplasty* (16) and *complete revascularization* (17–20) have previously been used to describe what we are presently naming *MV primary PCI* and *staged PCI*. We prefer these terms because the term *preventive* has traditionally been used to describe noninvasive interventions that attempt to prevent invasive interventions or major adverse cardiovascular events (MACE), and because complete revascularization was not routinely attempted in patients with chronic total occlusions, other complex lesions, or smaller arteries.

METHODS

A search of the published reports was performed using the PubMed database through December 2015. We included in our analysis previously published reports that were cited in previous publications and any additional studies that were independently identified. When possible, we excluded patients with non-ST-segment elevation myocardial infarction, hemodynamic instability, prior fibrinolytic therapy, and prior coronary artery bypass surgery. We documented study design and enrollment periods, primary endpoints, and quantitative mortality results; and separated MV primary PCI and staged PCI results. Qualitative results for MACE, reinfarction, and repeat revascularization were tabulated because the studies were too heterogeneous to permit an accurate quantitative analysis. Twelve reports were excluded from this analysis: 4 included patients with non-ST-segment elevation acute coronary syndromes (21–24); 3 did not separate MV primary PCI from staged PCI (25–27); 2 compared complete versus incomplete revascularization (28,29); 2 studied patients with heart failure and cardiogenic shock (30,31); and 1 compared MV primary PCI with single-vessel primary PCI (32).

To illustrate the relative effectiveness of CVO versus MV PCI, we used conventional statistical methods to create forest plots to illustrate differences in mortality rates, a relevant endpoint reported in all trials comparing primary PCI strategies in patients with STEMI and MV CAD. We applied a random effects model to acknowledge the variation in study design, treatment duration, and length of follow-up among the studies. For inductive inference and to emulate the random effects model, we used hierarchical Bayesian meta-analysis. In the absence of strong evidence for the superiority of 1 strategy over another, we used noninformative priors defined by a treatment effect of 0.00 and precision of 0.0001 to ensure that the posterior inference would be dominated by the likelihood of the data (33,34). All analyses were intention-to-treat. Standard meta-analysis was performed using the open-source statistical program R 3.0.2 and the library package meta 3.8-0 (35). Bayesian computations were run with the open-source program OpenBUGS 3.2.3 (Open Bayesian Inference Using Gibbs Sampling), using Markov chain Monte Carlo modeling (34,36), linked to R with BRugs (37).

CVO VERSUS MV PRIMARY PCI. We identified 6 single-center (38–43), 8 multicenter (44–51), and 3 case-controlled (52–54) observational reports that compared CVO versus MV primary PCI (**Table 1**). In general, in the current era with new-generation stent implantation and dual antiplatelet therapy, there appeared to be no increased risk for reinfarction when asymptomatic periprocedural myocardial biomarker elevations were not counted as events. The risk for repeat revascularization was inconsistently lower with MV primary PCI in these studies, but was never

ABBREVIATIONS AND ACRONYMS

ACC = American College of Cardiology

ACCF = American College of Cardiology Foundation

AHA = American Heart Association

BCI = Bayesian confidence interval

CAD = coronary artery disease

CI = confidence interval

CVO = culprit-vessel only

ESC = European Society of Cardiology

FFR = fractional flow reserve

MACE = major adverse cardiovascular event(s)

MV = multivessel

OR = odds ratio

PCI = percutaneous coronary intervention

SCAI = Society for Cardiovascular Angiography and Interventions

STEMI = ST-segment elevation myocardial infarction