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Percutaneous Coronary Intervention in 2018

Deepak L. Bhatt, MD, MPH

Managing patients with coronary artery stenosis has substantially improved since percutaneous transluminal coronary angioplasty with balloon inflation was introduced in 1977. At that time, cardiac surgery dominated, and percutaneous transluminal coronary angioplasty was limited to the most favorable lesions; the procedure had a relatively high complication and failure rate. Rapid advances in technology have inverted the balance such that most coronary artery lesions needing intervention are now treated with stents.

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Stent technology has evolved from bare-metal stents through a series of new-generation drug-eluting stents that have decreased restenosis rates and the need for repeat revascularization procedures. Paradoxically, first-generation drug-eluting stents had a greater risk of stent thrombosis than their predecessor bare-metal stents, especially for late (1-12 months after percutaneous coronary intervention [PCI]) and very late stent thrombosis (>1 year after PCI). Current-generation drug-eluting stents have overcome these problems and now have lower rates of stent thrombosis than did first-generation drug-eluting stents, with rates that are probably lower than with bare-metal stents. The better performance of newer-generation stents in reducing thrombosis and restenosis rates resulted from iterative improvements in drug elution and stent design. Collectively, these changes in stents have led to better efficacy and safety in the management of coronary artery stenosis.

The appropriate indications for PCI have been the source of much discussion in 2018, which resulted from the publication of the ORBITA (Objective Randomised Blinded Investigation With Optimal Medical Therapy of Angioplasty in Stable Angina) trial of 230 patients with stable angina.[1] It was a sham-controlled trial of PCI, finding no significant improvements in exercise time 6 weeks after the procedure for patients randomized to receive PCI. The trial design was rigorous, but the study was underpowered for clinical end points, although it did show a lack of symptomatic benefit for PCI for patients with single-vessel disease treated with optimal medical therapy who had a small angina burden.

The ORBITA trial results were consistent with the much larger COURAGE (Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation) trial of 2287 patients with stable angina, of whom 1149 were randomized to receive PCI.[2] COURAGE had already shown in 2007 that PCI for stable angina with modest amounts of ischemia did not reduce myocardial infarction or death. In the COURAGE trial, patients treated medically and by PCI had significant relief of angina symptoms, and PCI did confer an incremental benefit relative to medical therapy. It is true that there was an overuse of stents for patients with minimal angina in the United States prior to and immediately after COURAGE,[3] but inappropriate PCI use has waned. Current guidelines recommend PCI for single-vessel disease only when significant symptoms and ischemia are present, despite maximally tolerated medical therapy.[4]

The COURAGE and ORBITA trials were of stable angina and have no relevance to patients with acute coronary syndromes (ACS). In ACS, early invasive treatment (within 24-48 hours) with cardiac catheterization and appropriate revascularization remains the preferred treatment for patients with unstable angina or non–ST-segment elevation myocardial infarction (NSTEMI) ACS when prohibitive comorbidities are absent (**Table**).[9] The benefits are greater among higher-risk patients, such as those with dynamic electrocardiographic changes (eg, ST-segment depression that occurs with chest pain). When patients present with ACS, approximately 60% will receive PCI, with the remainder undergoing coronary artery bypass grafting (CABG) or receiving medical therapy alone. Under these circumstances, invasive treatment results in reduced myocardial infarction and death .

With the advent of very sensitive troponin assays, true unstable angina is diagnosed less frequently, with many of these patients now being categorized as having NSTEMI because of elevated troponin levels. Reclassification of patients to NSTEMI may result in greater use of coronary angiography and PCI for these patients who may not have undergone the procedure when they were diagnosed as having unstable angina.

In patients with STEMI ACS, prompt catheterization typically followed by primary PCI is the treatment of choice if this can be accomplished with a door-to-balloon time of no more than 90 to 120 minutes. In this setting, primary PCI results in a mortality benefit with a lower risk of intracranial hemorrhage than if the patient were treated with fibrinolysis. The larger the STEMI (such as an anterior wall STEMI) and the sicker the patient (such as with cardiogenic shock), the greater the benefit of primary PCI vs fibrinolytic therapy, even if there is some delay in undergoing PCI.

How to best manage stable multivessel disease with significant ischemia is not always clear. Patients with severe multivessel disease who are candidates for revascularization with either PCI or CABG have fewer repeat procedures when they undergo CABG rather than PCI. Patients with diabetes and multivessel disease have a lower mortality rate with CABG than they do with PCI, assuming that the patients are suitable candidates for either procedure.[5] CABG is associated with a higher stroke rate than PCI, and if a patient has a high baseline risk for stroke, PCI may be preferable. CABG also has higher rates of atrial fibrillation and wound complications. The mortality advantage for CABG over PCI takes approximately 5 years to manifest. Thus, the decision regarding the optimal revascularization strategy in patients with diabetes and complex multivessel disease is complicated and best made with the involvement of a heart team that includes both interventional cardiologists and cardiac surgeons.

Until recently, left main coronary artery disease has been considered the province of surgery. However, with improved stent

Table. Timing of Percutaneous Coronary Intervention (PCI) Based on Clinical Syndrome

	Clinical Syndrome		
	Stable Angina	NSTEMI or Unstable Angina	STEMI
Estimated % treated with PCI[a]	≈20	≈60	≈90
Angiogram findings	Severe stenosis	Ulcerated lesion	Occlusive lesion
Timing of PCI	Electively, after patient begins maximally tolerated medical therapy, if substantial symptoms and ischemia persist	Urgently, within 24 to 48 hours, ideally within 24 hours; emergently, if ongoing symptoms or dynamic ECG changes	Emergently, within 90-120 minutes, ideally within 60 minutes
Effect of PCI	Improves angina and reduces future need for urgent revascularization in severe single-vessel disease; advantages and disadvantages vs coronary artery bypass grafting in multivessel disease and in left-main disease[2,5,6]	Reduces the composite of death or myocardial infarction[7]	Reduces death[8]
What happens if PCI is not performed	Continued need for antianginal medications, which may require dose escalation with time; when medications are no longer effective there may be a need for elective or urgent revascularization	Stress test prior to discharge, and if there is significant ischemia, coronary angiography and revascularization based on coronary anatomy	Treatment with fibrinolytics, with prompt transfer for probable PCI

Abbreviations: ECG, electrocardiogram; NSTEMI, non-ST-segment elevation myocardial infarction.

[a] The remaining patients are treated with medical therapy alone or coronary artery bypass grafting.

technology, the question arose whether in patients who were anatomically candidates for either procedure, could PCI be used instead of CABG? The EXCEL (Effectiveness of Left Main Revascularization) and NOBLE (Nordic-Baltic-British Left Main Revascularization) randomized clinical trials of left main stenting vs CABG showed similar mortality rates with intermediate follow-up, although longer-term outcomes are still being obtained.[6] If a patient is clinically and anatomically suitable for either PCI or CABG, PCI will result in a higher rate of repeat revascularization but much faster recovery from the initial procedure. Both procedures yield significant and similar improvements in quality of life. It is common for there to be concurrent multivessel and left main disease. In this circumstance, CABG is likely a more durable revascularization procedure.

Thus, recent advances in PCI technology and technique, as well as refinements in application of PCI to appropriate patients, have greatly improved the utility of this common procedure.

ARTICLE INFORMATION

Author Affiliations: Brigham and Women's Hospital Heart and Vascular Center; Harvard Medical School, Boston, Massachusetts.

Corresponding Author: Deepak L. Bhatt, MD, MPH, Brigham and Women's Hospital Heart and Vascular Center, Harvard Medical School, 75 Francis St, Boston, MA 02115 (dlbhattmd@post.harvard.edu).

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