EDITORIAL

Standardizing definitions for hybrid coronary revascularization

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The optimal revascularization strategy for patients with multivessel coronary artery disease remains controversial. Coronary artery bypass grafting (CABG) surgery is still considered the criterion standard, but percutaneous coronary intervention (PCI) has become the preferred strategy for most patients with coronary artery disease.[1,2] Numerous studies have compared outcomes after CABG and multivessel PCI. In general, it is accepted that CABG surgery has the advantage of superior long-term freedom from repeat revascularization, as well as a survival benefit in certain high-risk groups, but that these benefits come at the expense of a higher risk of periprocedural stroke and other in-hospital complications, as well as a longer recovery time.[3-5] An alternative approach that would combine both CABG and PCI was first developed in the late 1990s.[6] This integrated approach was subsequently referred to as "integrated coronary revascularization" or "hybrid coronary revascularization" (HCR), in which the term *hybrid* reflected the mixture of therapies drawn from different subspecialties (CABG and PCI) that were used to achieve coronary revascularization. The current evidence for the use of HCR is limited to nonrandomized, single-institution or multicenter experiences that have used various clinical criteria and definitions, as well as techniques.[7,8] For comparative effectiveness studies, as well as for the use in clinical practice, a more uniform definition of HCR is of utmost importance. In this article, we will discuss the currently used definitions and the issues that arise when implementing these definitions, and we will propose a more uniform definition of HCR derived from existing definitions.

CURRENTLY USED DEFINITIONS

A number of societies, including the Society of Thoracic Surgeons (STS), National Cardiovascular Data Registry CathPCI Registry, American College of Cardiology, and European Society of Cardiology, have introduced definitions for hybrid procedures in the setting of coronary revascularization.[9-13] Table 1 summarizes the various definitions that are currently applied by these national databases and national and international societies. The widest definition is used by the STS, in which hybrid procedures include all planned and unplanned combinations of procedures that combine a surgical and transcatheter interventional approach during a single hospital stay.[9] The guidelines of the joint American societies on PCI[11] and CABG[12] use a much stricter definition for HCR, in which procedures have to be planned and should involve a combination of left internal thoracic artery (LITA) to left anterior descending artery (LAD) grafting and PCI of at least one non-LAD coronary artery. As can also be seen in Table 1, the definition of HCR in comparison studies registered at clinicaltrials.gov also follow these stricter joint American society guideline definitions, suggesting that this definition reflects the most optimal strategy for performing HCR. The question is whether these restricted definitions should be used or whether definitions should be expanded to include other, less favorable, combinations of percutaneous and surgical revascularization techniques.

THE ISSUE OF "UNPLANNED" HCR PROCEDURES

There is debate regarding whether to include patients whose procedures are considered "unplanned" when surgical and percutaneous coronary revascularization are performed in 2 stages. In the STS database, for instance, cases were considered unplanned HCR when either PCI or CABG was performed after incomplete revascularization or graft closure during the same hospital admission.[9] The inclusion of graft closure is particularly troublesome, and in our view unplanned HCR for these cases is a misnomer for a CABG procedure that was complicated by acute graft failure that required a repeat intervention. The converse misclassification may also occur, when CABG is performed because of complications arising from PCI. In our opinion, these cases should not be considered HCR procedures; rather, they should be classified as complications of the index procedure. Complementarily, patients undergoing CABG who subsequently undergo PCI because of incompletely revascularized territories that were not grafted should be considered as undergoing unplanned HCR.

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Disclosures: John H. Alexander reports research grants from Bristol Myers Squibb, CLS Behring, National Institutes of Health, and Regado Biosciences and consulting fees for Moerae Matrix and VA Cooperative Studies program. Michael E. Halkos reports consulting fees from Intuitive. All other authors have nothing to disclose with regard to commercial support.

Received for publication Oct 13, 2013; accepted for publication Oct 23, 2013; available ahead of print Nov 25, 2013.

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J Thorac Cardiovasc Surg 2014;147:556-60

0022-5223/$36.00

http://dx.doi.org/10.1016/j.jtcvs.2013.10.019

TABLE 1. Currently used definitions for hybrid coronary revascularization

Guideline/registry	Definition
2011 ACCF/AHA/SCAI Guidelines for PCI; 2011 ACCF/AHA Guidelines for CABG[11,12]	The planned combination of LITA-LAD artery grafting and PCI of ≥1 non-LAD coronary arteries. Hybrid coronary revascularization may be performed in a hybrid suite in a single operative setting or as a staged procedure (PCI and CABG performed in 2 different operative suites, separated by hours to 2 d, but typically during the same hospital stay).
2010 ESC/EACTS Guidelines on Myocardial Revascularization[10]	Planned, intentional combination of CABG, with a catheter-based intervention to other coronary arteries during the same hospital stay. Procedures can be performed consecutively in a hybrid operating room or sequentially on separate occasions in the conventional surgical and PCI environments.
STS Adult Cardiac Registry National Database (version 2.73)[9]	A *hybrid procedure* is defined as a procedure that combines surgical and transcatheter interventional approaches: (1) planned, concurrent is performed in same setting; (2) planned, staged is performed in the same hospital admission; (3) unplanned is performed after incomplete revascularization or graft closure during the same hospital admission.
NCDR CathPCI Registry (version 4.4)[13]	Hybrid therapy occurs when both surgical and percutaneous coronary revascularization are planned, with different lesions treated with the different techniques.
Clinicaltrials.gov (definitions by registered studies)	Minimal invasive LITA-to-LAD and PCI of non-LAD lesions. Procedures can be performed either in the same operating suite or during the same hospitalization

ACCF, American College of Cardiology Foundation; *AHA*, American Heart Association; *SCAI*, Society for Cardiovascular Angiography and Interventions; *PCI*, percutaneous coronary intervention; *CABG*, coronary artery bypass grafting; *LITA*, left internal thoracic artery; *LAD*, left anterior descending artery; *ESC*, European Society of Cardiology; *EACTS*, European Association for Cardio-Thoracic Surgery; *STS*, Society of Thoracic Surgeons; *NCDR*, National Cardiovascular Data Registry.

HCR PROCEDURES IN THE SETTING OF ACUTE ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION

It is controversial whether patients with acute ST-segment elevation myocardial infarction who underwent PCI (with or without stenting) for the infarct related artery and subsequent emergency CABG through a sternotomy of the non–infarct related coronary arteries should be considered as having undergone HCR. This warrants special consideration for patients in whom the LAD was initially treated percutaneously with balloon angioplasty only. In these patients, angioplasty is typically used to interrupt the infarct, and the LAD is typically then bypassed during CABG surgery. The latest European guidelines on myocardial revascularization consider acute ST-segment elevation myocardial infarction cases in which primary PCI is performed for a non-LAD culprit vessel followed by CABG for complete revascularization as procedures performed with a ''hybrid approach.''[10] The CathPCI Registry and the STS registry consider these cases planned hybrid procedures, as long as both procedures are performed during the same hospital admission.[13] In our opinion, patients undergoing emergency PCI of the infarct-related artery followed by CABG of both the infarct-related artery and non–infarct related territories should not be considered HCR. Patients who undergo emergency or urgent PCI of an infarct-related artery followed by bypass grafting of non–infarct-related territories, however, should technically be considered as undergoing HCR procedures as long as the decision to follow this approach was made before PCI was undertaken.

WHAT IF A BYPASS GRAFT OTHER THAN THE LITA IS USED FOR HCR?

The rationale for performing HCR in most cases is to provide revascularization to the LAD with the LITA, because of its superior patency.[14] In some cases, however, multiple left-sided arterial grafts are performed with either internal thoracic artery used to graft the LAD and 1 or more other left-sided targets. In these cases, PCI is used to treat the right coronary or the remaining left non-LAD coronary arteries. Similarly, saphenous vein grafts may also be used to graft LAD or non-LAD left-sided vessels, followed by PCI of remaining vessels. For purposes of definition, these cases should be considered hybrid cases. Currently, an increasing number of cases are being reported in which minimally invasive double internal thoracic artery grafting is combined with PCI for treatment of complex multivessel disease.[15] A subclassification, such as ''advanced HCR'' or ''complex HCR,'' has been proposed for these procedures, to differentiate these cases from HCR that uses single-vessel CABG.

WHAT IF THE SURGICAL PROCEDURE IS PERFORMED THROUGH A CONVENTIONAL STERNOTOMY?

Although most centers that perform HCR use minimally invasive techniques, one should also consider the use of