Clinical outcomes after hybrid coronary revascularization versus coronary artery bypass surgery: a meta-analysis of 1,190 patients

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Background Hybrid coronary revascularization (HCR) represents a minimally invasive revascularization strategy in which the durability of the internal mammary artery to left anterior descending artery graft is combined with percutaneous coronary intervention to treat remaining lesions. We performed a systematic review and meta-analysis to compare clinical outcomes after HCR with conventional coronary artery bypass graft (CABG) surgery.

Methods A comprehensive EMBASE and PUBMED search was performed for comparative studies evaluating in-hospital and 1-year death, myocardial infarction (MI), stroke, and repeat revascularization.

Results Six observational studies (1 case control, 5 propensity adjusted) comprising 1,190 patients were included; 366 (30.8%) patients underwent HCR (185 staged and 181 concurrent), and 824 (69.2%) were treated with CABG (786 off-pump, 38 on-pump). Drug-eluting stents were used in 328 (89.6%) patients undergoing HCR. Hybrid coronary revascularization was associated with lower in-hospital need for blood transfusions, shorter length of stay, and faster return to work. No significant differences were found for the composite of death, MI, stroke, or repeat revascularization during hospitalization (odds ratio 0.63, 95% CI 0.25-1.58, $P = .33$) and at 1-year follow-up (odds ratio 0.49, 95% CI 0.20-1.24, $P = .13$). Comparisons of individual components showed no difference in all-cause mortality, MI, or stroke, but higher repeat revascularization among patients treated with HCR.

Conclusions Hybrid coronary revascularization is associated with lower morbidity and similar in-hospital and 1-year major adverse cerebrovascular or cardiac events rates, but greater requirement for repeat revascularization compared with CABG. Further exploration of this strategy with adequately powered randomized trials is warranted. (Am Heart J 2014;167:585-92.)

Hybrid coronary revascularization (HCR) refers to the use of surgical and percutaneous techniques that are combined to establish complete coronary revascularization in patients with multivessel coronary artery disease (CAD). According to the latest revascularization guidelines, HCR with the use of the internal mammary artery (IMA) for bypassing the left anterior descending (LAD) and percutaneous coronary intervention (PCI) of non-LAD coronary lesions has been recognized as a feasible alternative to coronary artery bypass grafting (CABG) surgery in selected patients.[1–3] In theory, the use of HCR may have a number of advantages over CABG surgery: (1) minimal invasive techniques may lead to faster recovery and fewer in-hospital complications; (2) avoidance of saphenous vein grafts for non-LAD disease, which carry additional procedural risk and have poor patency rates when compared with the latest drug-eluting stents (DES).[4,5] In the present study, our goals are to provide an overview of evidence for the use of HCR as an alternative for CABG and to gain insights for future randomized clinical trials that involve HCR in patients with multivessel CAD.

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Methods

Data source and exclusion criteria

A comprehensive literature search was performed from electronic databases including Cochrane Library, EMBASE, and MEDLINE updated to June 26, 2013. The terms "hybrid coronary

revascularization," "hybrid myocardial revascularization," "integrated myocardial revascularization," and "coronary artery disease" and their variations were used as keywords in a PubMed search. The search was limited to records in humans. Both English and non-English language articles were included (n = 247). Two independent reviewers (R.E.H., A.B.) screened all citations by using a hierarchical approach of assessing the title, abstract, and the article. Studies of HCR for *multivessel CAD*, referred to the use of a combination of surgical and percutaneous techniques to establish coronary revascularization, performed either simultaneously in a single setting or in 2 stages within hours, days, or weeks were included. Bibliographies of all selected articles were reviewed to identify additional studies. Exclusion criteria were studies that did not have a comparison CABG group, included patients with concomitant hybrid valve procedures, or were review articles or commentaries. Data from abstracts and unpublished studies were not included. Quality of observational studies was determined based on completeness of reporting, reporting of adjusted risk of outcomes, use of propensity adjustment, or absence of differences between reported baseline variables in the 2 treatment groups—representing high-quality studies. Data were abstracted by 2 reviewers in a blinded manner, and discrepancies were resolved by consensus.

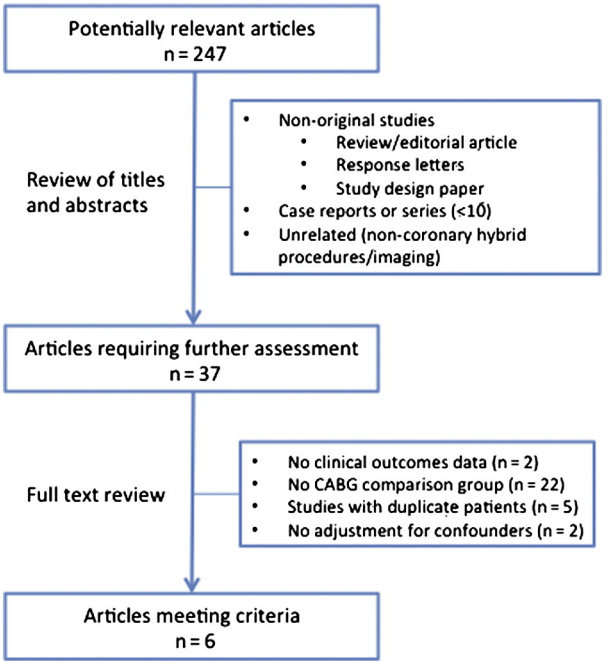
Definitions and study end points

Hybrid coronary revascularization was defined as the use of a combination of surgical and percutaneous techniques that involved IMA-to-LAD and PCI of the non-LAD, which could have been performed consecutively in a single setting or staged in which PCI and CABG were performed separately within hours, days, or weeks. *Coronary artery bypass grafting surgery* was defined as the use of surgical techniques to establish coronary revascularization with the use of arterial and/or vein grafts using a trans-sternal approach with or without the use of cardiopulmonary bypass. In-hospital outcomes included death, stroke, myocardial infarction (MI), repeat revascularization, new onset of atrial fibrillation, significant bleeding, and hospital length of stay. *Longer-term outcomes* were defined as cumulative clinical events occurring for the complete follow-up duration. Because studies reported outcomes at various follow-up time intervals (1-5years), authors were contacted to provide 1-, 2-, and 3-year clinical follow-up data for the primary end point of death, MI, stroke, and repeat revascularization as well as individual components.

Statistical analysis

Continuous data are expressed as mean ± SD, and dichotomous data are expressed as absolute value and percentages. Meta-analysis was performed per recommendations of the Cochrane Collaboration and the MOOSE statement.[6] Heterogeneity was assessed by means of the Cochran Q test. Statistical value I^2 represents the degree of inconsistency, with a score of 25%, 50%, and 75% indicating low, moderate, and high levels of inconsistency, respectively. P value for the test of heterogeneity of less than .05 was considered to indicate heterogeneity between studies. Differences between the 2 groups for in-hospital and long-term outcomes were assessed by as the number of events and number of patients in each group and estimated by odds ratios (ORs) with 2-tailed 95% CIs. Random-effects models were used because heterogeneity among studies was expected. Studies with zero events in one group or total zero events were included, and a continuity correction of 0.5 was used.[7] Potential publication bias was assessed by funnel plots and adjusted using Duval and Tweedie's[8] trim-and-fill methodology. A sensitivity analysis was performed to compare HCR performed as a concurrent procedure or as a 2-stage procedure separately with CABG surgery. All statistical analyses were performed using the Comprehensive Meta-Analysis software package version 2.2 (Biostat, Englewood, NJ).

Figure 1



Flow diagram of study selection process.

Results

Studies selection

The study selection process is illustrated in Figure 1. The search strategy identified 247 studies. After screening of titles and abstracts, we excluded nonoriginal studies, case reports, or small case series (<10) and unrelated studies on noncoronary hybrid surgical or imaging procedures. This resulted in 37 unique studies that were comprehensively reviewed. After critical appraisal, we excluded 27 studies because of the lack of a comparative study arm, clinical outcome was not provided, or outcome data were provided without adjustment for confounders. This led to a total of 6 studies, which were included in the meta-analysis, and data on in-hospital and/or long-term clinical outcomes were further scrutinized.[9-14]