

## Hybrid coronary revascularization: first choice or alternative?

“Coronary artery bypass grafting in all its forms remains the first choice in coronary revascularization and hybrid coronary revascularization is a good alternative in high-risk patients.”

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Hybrid coronary revascularization (HCR) is an approach that aims to combine the ‘best of both worlds’ of cardiology and cardiac surgery by attempting to achieve the maximum effect of revascularization in the least invasive way possible. HCR has been gaining ground lately due to advances in technology and techniques, an increasing acceptance of the ‘heart team’ approach and its popularity among patients and care teams.

Much of HCR remains controversial – by definition, with regard to timing, techniques, equipment, patient selection criteria, and the implementing team’s learning curve. It is not this editorial’s purpose to sort out the technical aspects in the application of HCR. Rather, its purpose is to rationalize the appropriateness of HCR in being included in the armamentarium of coronary artery disease treatments.

HCR has been practiced since the advent of percutaneous approaches, and more commonly as unplanned approaches to either salvage CABG or salvage PCI. The first series of planned HCR were attempts to provide adequate revascularization for high-risk patients. These attempts, published in 1996, yielded acceptable results. Since then, more literature has come out about its efficacy, and it is now included in several revascularization guidelines [1,2].

In the 2011 guidelines for the treatment of coronary artery bypass grafting (CABG) by the American College of Cardiology Foundation/American Heart Association, HCR was defined as a planned combination of left internal mammary artery – left anterior

descending artery (LIMA-LAD) with percutaneous coronary intervention (PCI) to non-LAD coronary arteries. HCR was given a Class IIa recommendation in cases where there are limitations to traditional CABG (heavily calcified aorta, poor target vessels), a lack of suitable conduits or an unfavorable LAD for PCI in select two-vessel disease patients. A Class IIb recommendation was given to HCR as a possible reasonable alternative to multivessel PCI or CABG in order to improve the overall risk–benefit ratio [1].

More recently, the European Society of Cardiology/ European Association for Cardiothoracic Surgery included HCR in its 2014 Guidelines for Myocardial Revascularization. It defined HCR as consecutive or concurrent surgical and percutaneous revascularization, and gave it a Class IIb recommendation stating that HCR may be considered on specific patient subsets at experienced centers [2].

With the growing acceptance of HCR in the medical community, in addition to an increasing demand from patients for less invasive therapies, a mentality shift has been noted among healthcare practitioners toward expanding the indications of HCR, from initially allocating it only to high-risk patients, to placing it now as a possible first-line therapy for all-comers.

If HCR is to be accepted as a first-line approach for multivessel disease, it should be measured against the current gold standard in the treatment of multivessel CAD, which is CABG. It is uncontested that the most valuable revascularization in CABG is the



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LIMA-LAD graft. The controversy lies on the selection of the next best approach.

Several studies have shown that HCR (LIMA-LAD performed either conventionally or minimally invasively, plus PCI to non-LAD vessels) provides better short-term outcomes with regard to decreased ventilation and ICU time, reduced requirement for blood transfusion, and shortened hospital stay. But there has been no strong evidence on improved mortality, and late comparative outcomes are still insufficient [3–8].

One of the strongest areas of concern in modern CABG is the low saphenous vein graft (SVG) patency rate. Saphenous vein patency is 85% at 6 months, 71–93.8% at 1 year and 74–81% at 5 years [9–16]. (One exceptional study cites up to 95% patency at 5 years, but this is not the general trend in the literature, and the patency dropped to 61% at 10 years, and 32% at 15 years) [10]. With the restenosis rate of 1st generation drug-eluting stents (DES) being only 4.0% [17] (i.e., patency of 96% at 1 year), it seems reasonable to address the non-LAD lesions with PCI DES instead of CABG, especially because the 2(nd) generation DES boasts restenosis rates of only 2.8% at 1 year.

However, caution is advised in interpreting these comparisons.

The cited high SVG failure rate is mostly driven by the results from the PREVENT IV trial [9]. This trial included only patients with at least two vein grafts, and included those that were done in a sequential manner. More than half of the SVGs used were harvested endoscopically, the safety of which is still being contested. Also, the vein graft underwent pressure treatment as part of the protocol, a treatment which may have introduced biological modifications. Furthermore, postoperative medication was not optimized (aspirin in 90%, anti-lipids in only 72.4%, beta blocker in only 78.1%). Another source of caution is the fact that the SCAAR trial [17], which showed exceptional DES results, performed the study mostly on 1–2 vessel CAD, which is already known to be a good population for PCI.

A strong argument for surgical bypass grafts is that most native disease progression occurs in the proximal coronary segment. [14]. This implies that disease can progress at or near stents, with recurrence of ischemia. With surgical graft bypassing, most disease progression occurs proximal to the anastomosis, thereby preserving blood flow distally.

An arterial conduit revascularization approach can mitigate the nondurability of bypass grafts. Arterial conduits have shown an overall patency rate of 93.5% in 15 years. Even if there is a controversy about the best conduit, the sensitivity to the target territory, sensitivity to the severity of the native coronary dis-

ease and a tendency to spasm, enough data are now available to guide surgeons in choosing which conduit to use [10,11,13,18,19]. The LITA boasts of 95% patency, RITA of 81% patency and radial artery of 89% patency at 10 years [10,18]. These are remarkably better numbers than any present-day DES could lay claim to.

Graft optimization could be done both technically during the operation, as well as medically postoperatively. SVG failure is mainly caused by intimal hyperplasia. The CASCADE trial has shown that statin and  $\beta$ -blocker use decreases the reactive intimal hyperplasia in SVG grafts [14]. The antiplatelet protection provided by Clopidogrel to DES does not extend to SVGs. Further studies on newer-generation antiplatelets need to be done.

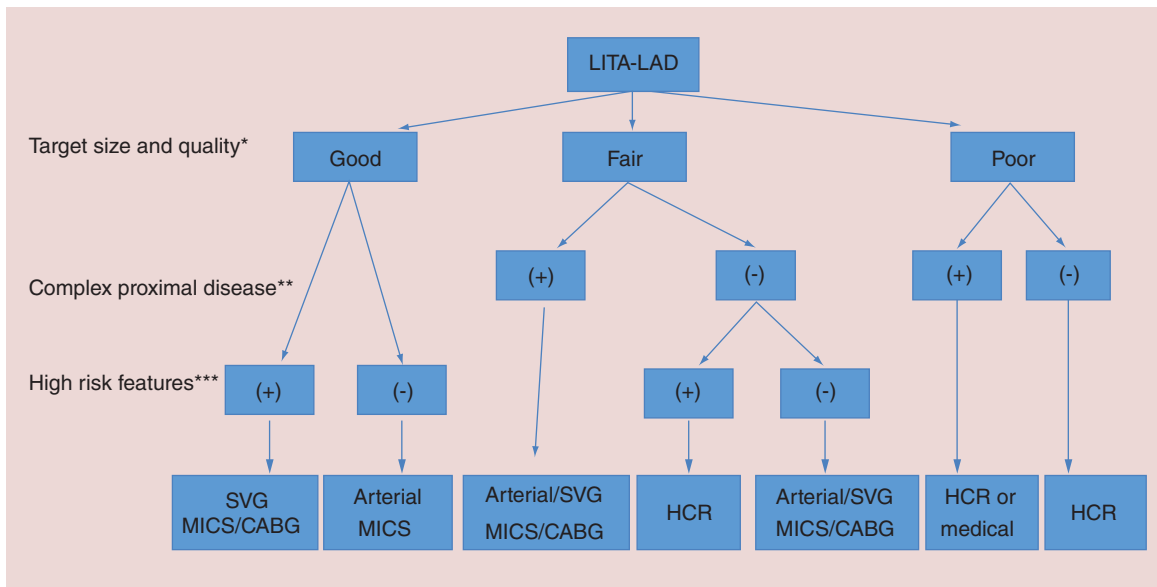
Another aspect in HCR is the evidence of decreased stroke rate when compared with conventional CABG. However, this is attributed to the shift to minimally invasive techniques and avoidance of aortic manipulation, and not to the hybrid nature of the approach itself. Even in conventional CABG, the stroke risk is present only in the first year of surgery, and equalizes in 3 years' time [20].

Splitting the sternum is a minor but very valid concern, physically and psychologically. Minimally invasive surgery is now flourishing with sternal-sparing approaches that can easily be incorporated in HCR, from mini-thoracotomies direct approach, to endoscopic, to totally endoscopic robot-assisted surgeries. The clinical research aspect is active for HCR. At least 11 researches are now listed at [clinicaltrials.gov](http://clinicaltrials.gov). Previous studies have elucidated on its cost–effectiveness. However, with changes in techniques, equipment and medications, findings have to be updated. These studies will definitely need to be addressed in deciding procedures that would be supported by an institution.

Certain practical considerations are probably what is keeping this novel technique from gaining even more support. There is a need for intense training in minimally invasive cardiac surgery (MICS), for availability of radiologic, interventional and surgical equipment, and of course, for a heart team with a cooperative frame of mind and a willingness to fit a common time among themselves.

Based on current literature, we are proposing an algorithm as aid in the decision-making with regard HCR and CABG (see Figure 1).

In summary, we believe that CABG in all its forms remains the first choice in coronary revascularization and HCR is a good alternative in high-risk patients. There is now improved understanding of the specificities of graft conduits that enable surgeons and physicians to provide excellent outcomes.



**Figure 1. Proposed algorithm in decision-making for hybrid coronary revascularization versus coronary artery bypass grafting.**

\*Target size at least 1.5 mm in diameter, and of good quality.

\*\*Complex proximal disease as per SYNTAX score and calcification.

\*\*\*High-risk features for surgery: acute coronary syndrome, ventricular dysfunction, frailty, peripheral vascular disease, renal failure, severe chronic obstructive pulmonary disease.

Other considerations in deciding the best approach: ascending aortic calcification, conduit availability and quality, severity of stenosis of native coronary vessel, territory of target vessel.

CABG: Coronary artery bypass grafting; HCR: Hybrid coronary revascularization; LITA: Left internal mammary artery; LAD: Left anterior descending artery; MICS: Minimally invasive cardiac surgery; SVG: Saphenous vein graft.

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