

# Hybrid approach to multivessel coronary artery disease: a commentary

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Hybrid coronary revascularization (HCR) intends to combine the advantages of both minimally invasive direct coronary artery bypass (MIDCAB) and percutaneous coronary intervention (PCI). Thus, HCR is a sternal-sparing, off-pump, minimally invasive, hand-sewn left internal mammary artery (LIMA) to left anterior descending (LAD) bypass graft through a 4–6 cm anterolateral minithoracotomy with PCI to non-LAD lesions, in order to achieve a functional complete revascularization. HCR should, in theory, provide the perfect revascularization: stents replace the need for the saphenous vein graft (SVG), and MIDCAB provides a minimally invasive approach to reduce surgical morbidity.

Historically, HCR has been offered only to high risk patients for standard sternotomy CABG (1). However, lately, HCR has been adopted in patients with multivessel (MV) coronary disease as an alternative strategy to CABG. This is primarily due to excellent clinical results of the latest generation of DES (2) and to the desire of both patients and cardiologists for less invasive options.

To date the known efficacy and safety of this novel approach is only supported by data obtained through small, single-center studies (3–7).

In their recent paper, “*Hybrid Coronary Revascularization for the Treatment of Multivessel Coronary Artery Disease: A Multicenter Observational Study*” (8), Puskas and coworkers conducted a study at 11 clinical centers in the US to refine the eligibility criteria for a future comparative effectiveness trial of HCR compared with MV PCI. Although the study is a combination of a prospective and a retrospective analysis on a limited cohort (183 hybrid vs. 89 PCI propensity score matched patients), it constitutes the first HCR multicenter trial clearly defining anatomic and clinical eligibility criteria

developed for a subsequent randomized comparative effectiveness trial of HCR vs. PCI. Left main (LM) disease has been indicated as an exclusion criteria for the PCI group, though introducing a potential bias.

Timing strategy both for HCR and PCI was left to the discretion of the treating clinicians. Patients admitted with unstable angina attributable to a critical stenosis in the RCA or CFX are first treated with PCI, followed by MIDCAB. When LAD is considered the culprit this order is reversed (MIDCAB followed by PCI). Only a few case of simultaneous combined surgical and PCI procedures has been performed (9,10).

Surgical approaches varied among centers according to surgeon preference. Robotic LIMA harvesting and left minithoracotomy for anastomosis should be considered equipollent to classic MIDCAB, whereas totally endoscopic coronary artery bypass surgery (TECAB) (42 cases in the study) should be probably excluded, since it has been clearly demonstrated that in endoscopic-robotic TECAB there are more technical errors than in standard beating heart surgery [OPCAB (1%) vs. TECAB (4.8%)] (11). Specifically these technical errors could explain the 2.5% incidence of PCI to the LIMA-LAD system in the HCR group.

Primary and secondary outcomes were the incidence of MACCE (defined as death, stroke, myocardial infarction or repeat revascularization at 12 and 21 months respectively following the initial procedure; this short term results don't provide clear indications as to whether either therapy is superior.

The propensity score adjusted event-free survival at 12 months was similar between the two groups [adjusted hazard ratio (HR): 1.063; adjusted 95% confidence interval (CI): 0.666 to 1.697]. Interestingly, by 18 months of follow-

up the MACCE-free survival curves for HCR *vs.* PCI began to diverge with increasing MACCE in the PCI group, although the difference did not reach statistical significance for the small number of patients/events. The stroke rate was higher in the HCR group, yet none occurred in temporal proximity to the surgical or percutaneous interventions.

Results of this observational multicenter study are really promising, but without convincing data from a randomized clinical trial, there is insufficient evidence to guide dissemination of this potentially important procedure to large patient populations.

Moreover other factors may contribute to limit a wider adoption of HCR including: a lack of co-operation between surgical and interventional groups, the logistical difficulties of timing and sequencing of procedures, the use of aggressive anticoagulation in surgical patients and the resistance of the wider surgical community to adopt minimally invasive techniques.

As a consequence of these issues, the status quo for the surgical treatment of MV CAD is an on pump sternotomy CABG with a single LIMA and multiple SVG, and interventional cardiologists, continue to treat MV and LM CAD patients with multiple DES, with the aim of avoiding surgical risk and satisfying the patient's desire for a less invasive treatment.

Both of these approaches have notable drawbacks.

Although the SYNTAX trial (12) provided evidence supporting the superiority of CABG for patients with severe MV disease, surgical revascularization imposes a heavy burden in terms of invasiveness, bleeding, adverse neurological events, infection and pulmonary complications, especially in elderly or at-risk patients. Also, SVGs commonly used to bypass non-LAD lesions in standard CABG are prone to occlusion. Routine post-operative angiography revealed 6–12 months occlusion rates ranging from 13–21% (13,14). However, 95% of CABG procedures carried out in the US, recorded in the Society of Thoracic Surgeons (STS) registry, employ SVGs (9). PCI, on the other hand, allows for the minimally invasive management of CAD, and as such can be associated with reduced costs and improved recovery periods. Nevertheless patients who undergo PCI are likely to require more repeat revascularization than CABG (12). However, recently released data from the Swedish Coronary Angiography and Angioplasty Register (SCAAR), a very large, long-term observational study, have shown that new-generation DES are associated with improved patient outcomes, compared with old-generation DES or bare metal stents (BMS) (5).

Clinical restenosis rates at 1 and 2 years respectively, were 6.3 and 7.4% in the BMS group, 4.0% and 5.8% in the old generation-DES group, and 2.8% and 3.9% in the new generation-DES group (5).

The time has come to convince surgeons that they should stop fully revascularizing patients with standard CABG and, at the same time, to convince interventional cardiologists that they can rely on surgery for an excellent method for LAD revascularization

Large MIDCAB series have been reported with excellent angiographic and clinical results (15) and this technique should be considered one of the standard surgical revascularization techniques. To further reduce chest trauma, thoracoscopic and robotic techniques (TECAB) have been employed for LIMA mobilization and LIMA-LAD anastomosis (16). However, to date, only a few surgeons have mastered such techniques, meaning their widespread adoption has not yet occurred.

Today, patients and referring cardiologists are asking surgeons to adopt this gold standard operation (LIMA on LAD), performed in a safe, effective and minimally invasive fashion, with an excellent success rate. As a surgeon involved in minimally invasive techniques, I think we must make MIDCAB accessible to all cardiac surgery centres, because, as previously discussed, one of the main reasons of HCR limited dissemination is the limited diffusion of minimally invasive techniques within the surgical community.

Cardiac surgeons performing safe and effective MIDCABs, may cooperate with interventional cardiologists thus reducing the need for complex LAD PCI, lowering the patient's SYNTAX score.

Interestingly, PCI has recently been proposed as an alternative strategy for patients with LM disease. In current guidelines (17) the procedure has been upgraded to class I for SYNTAX score <22 and IIb in case of SYNTAX score between 22 and 32 and several observational analyses have demonstrated comparable short- and mid-term survival between CABG and PCI for LM stenosis, despite a higher incidence of repeat revascularization in patients treated with PCI (18,19). The relatively large size of the LM is particularly attractive for PCI in patients with focal disease. Of note, LM PCI [LM-circumflex (CFX) stenting] should be performed more safely after recording a patent LIMA-LAD anastomosis, following MIDCAB surgery, and results for this procedure compare favourably with OPCAB outcomes (11). In case of isolated ostial LM PCI any graft (including LIMA-LAD) previously implanted is prone to occlude due to competitive flow in the native

arteries. Therefore only isolated ostial LM stenoses should be considered an exclusion criteria for HCR, to avoid a potential important bias when compared with PCI cohort.

Concerns about competitive flows suggest standard OPCAB with two mammarys as a wiser approach in patients with isolated ostial LM.

The traditional surgical criticism about PCI increased repeat revascularization rate should be carefully evaluated, especially when HCR is concerned. In the real world most candidates for HCR are not the patients who would otherwise get CABG, but who would instead be treated with MV PCI. These patients would, therefore, have a higher need for repeated revascularization without the advantages of the proven long-term durability of a LIMA-LAD graft. So the real open question is whether the HCR cohort has better short- and long-term survival and reduced incidence of adverse in-hospital events compared with OPCAB, combined with a lower requirement for repeat revascularization compared with MV PCI, since LIMA-LAD should reduce repeat revascularization of proximal LAD disease. Thus, by successfully combining these positive features it is possible to provide the survival advantage of LIMA-LAD bypass with minimally invasive nature of PCI: a 'best of both worlds' strategy.

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