Hybrid coronary revascularization in multivessel coronary artery disease: who can benefit most? A pilot study

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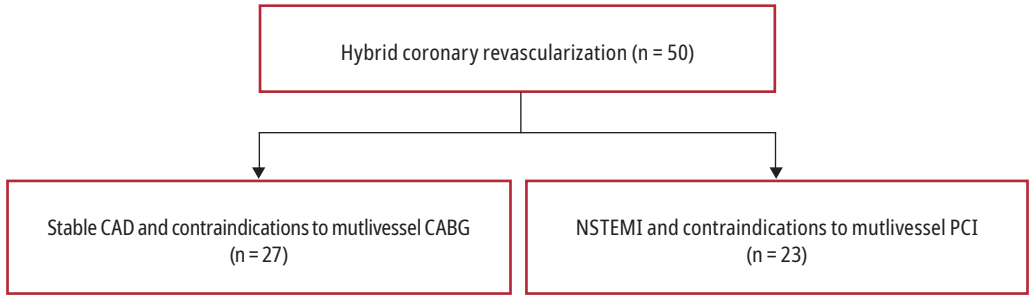
Introduction Despite the development of interventional cardiology, grafting the left internal mammary artery (LIMA) to the left anterior descending artery (LAD) is considered the gold standard in revascularization, improving both short- and long-term survival.[1] However, standard coronary artery bypass grafting (CABG) through sternotomy is an invasive procedure with limited rates of saphenous vein graft patency. Minimally invasive coronary artery bypass (MIDCAB) grafting helps to avoid the burden of an open-chest procedure and maintain the benefit of the LIMA–LAD graft.[2] On the other hand, it is estimated that in 35% of all patients undergoing percutaneous coronary intervention (PCI), significant coronary artery calcifications are present. This may lead to reduced stent deliverability, higher rates of periprocedural complications, stent malposition or underexpansion, and unfavorable long-term outcomes as compared with outcomes for noncomplex lesions.[3] In such population of patients, the PCI-only strategy may be insufficient to achieve optimal results. Therefore, hybrid coronary revascularization (HCR), that is, MIDCAB combined with PCI, can be an effective strategy to obtain complete revascularization while reducing the periprocedural risk.

However, the safety and efficacy of HCR remains a matter of debate and the procedure is relatively rarely performed. In our center, HCR procedures constitute only around 1% of all CABG procedures. The most prominent trials reported a similar mortality and incidence of major adverse cardiovascular events at 1-, 2- and 5-year follow-up for HCR, multivessel CABG, and multivessel PCI.[4-6] However, in all randomized controlled trials, the eligibility for revascularization strategies was an inclusion criterion. Moreover, no data are available on HCR outcomes in patients with non–ST-segment elevation acute coronary syndrome (NSTE-ACS).[7]

Methods The prospective HCR registry was set up in 2018 and collects records of all patients undergoing HCR in our institution. The registry includes 2 novel groups of patients, that is, individuals with NSTE-ACS or stable coronary artery disease (SCAD) in whom both standard multivessel CABG (due to median sternotomy or predicted completeness of surgical revascularization) and multivessel PCI (due to high complexity of the LAD lesion) are contraindicated (FIGURE 1).

Fifty consecutive patients who underwent HCR between January 2017 and April 2020 were enrolled in this study. All patients were deemed eligible for HCR (MIDCAB with the LIMA–LAD shunt combined with PCI using drug-eluting stents to non-LAD lesions) by the local Heart Team, as the cohort was ineligible for PCI-only or CABG-only strategies. The SYNTAX score was calculated for all patients by 2 independent interventional cardiologists. Stable CAD was an indication for revascularization in 54% of patients, and NSTE-ACS, in 46%.

For patients with NSTE-ACS, urgent PCI to the culprit lesion was performed and delayed MIDCAB, regarded as the second revascularization stage. The median delay was 77 (46–115)



Variable	Stable CAD	NSTEMI	*P* value
EuroSCORE II, median (IQR)	2.28 (1.45–3.34)	1.21 (0.82–1.47)	0.001
Overall SYNTAX score, median (IQR)	25 (20–34)	25.25 (16.25–31)	0.53
LAD artery SYNTAX score, median (IQR)	16 (11–17)	13 (9–20.75)	0.66
LM stenosis, n (%)	7 (29.2)	1 (4.3)	0.02
Two-vessel disease, n (%)	19 (70.4)	10 (43.5)	0.06
Three-vessel disease, n (%)	8 (29.6)	13 (56.5)	
Age, y, median (IQR)	70.5 (63–78)	67 (57–73.5)	0.023
Peripheral artery disease, n (%)	13 (48)	2 (8.7)	0.002
GFR, ml/min/1.73 m^2, median (IQR)	64 (58–83)	79.5 (69–88.5)	0.048
DAPT, n (%)	16 (59.3)	23 (100)	0.001
24-hour chest tube output, ml, median (IQR)	430 (270–500)	375 (350–585)	0.96
Post-MIDCAB cTnI, µg/l, median (IQR)	0.06 (0.04–0.13)	0.07 (0.05–0.1)	0.55

FIGURE 1 Study flowchart

Abbreviations: CABG, coronary artery bypass grafting; CAD, coronary artery disease; DAPT, dual antiplatelet therapy; GFR, glomerular filtration rate; IQR, interquartile range; LAD, left anterior descending; LM, left main; MIDCAB, minimally invasive coronary artery bypass; NSTEMI, non–ST-segment elevation myocardial infarction; PCI, percutanous coronary intervention

days. The timing of revascularization stages for patients with SCAD was determined by the Heart Team—59.3% of patients with SCAD had PCI performed first, then MIDCAB at a median delay of 105 (76–150) days. MIDCAB with subsequent PCI was performed in 40.7% of patients with SCAD, with a median time of 7 (6–37) days between the procedures (P = 0.34 for NSTE-ACS vs SCAD).

Statistical analysis Statistical analysis was performed using the IBM SPSS Statistics software for Windows, version 26.0 (IBM Corp., Armonk, New York, United States). Normal distribution was tested with the Kolmogorov–Smirnov test. Qualitative variables were expressed as number and percentage, and the χ^2 test was used to compare the study groups. For quantitative variables, median and interquartile range (IQR) were calculated and nonparametric tests were used (Mann–Whitney and Kolmogorov–Smirnov tests for ordinal data). A 2-tailed P value less than 0.05 was considered significant.

All study participants provided informed consent. The study design was approved by the appropriate ethics review board (1072.6120.140.2019).

Results and discussion Patients with SCAD, compared with the NSTE-ACS group, were at higher perioperative risk (median [IQR] EuroSCORE II, 2.28 [1.45–3.34] vs 1.21 [0.82–1.47]; P <0.001), mostly due to older age (median [IQR] age, 70.5 [63–78] vs 67 [57–73.5] years; P = 0.02), peripheral artery disease (48% vs 8.7%; P = 0.002), and impaired renal function (median [IQR] glomerular filtration rate, 64 [58–83] vs 79.5 [69–88.5] ml/min/1.73 m^2; P = 0.048). The median (IQR) SYNTAX score was similar in both groups (25 [20–34] vs 25.25 [16.25–31]; P = 0.53), with highly complex LAD lesions (16 [11–17] vs 13 [9–20.75]; P = 0.66). Left main stenosis was more commonly observed in the SCAD group (29.2% vs 4.4%; P = 0.02).

Contraindications to multivessel CABG were more common in patients with SCAD (66.7% vs 8.7%; P <0.001). Advanced age combined with frailty syndrome and obesity represented the most frequent contraindications to full median sternotomy; however, a single case of previous cardiac surgery was noted. Surgical inability to achieve complete revascularization mostly resulted from a small coronary vessel diameter and calcium deposits at the potential grafting

site; however, the lack of vein graft material was also reported in a single patient.

Prior to MIDCAB, the NSTE-ACS group received dual antiplatelet therapy (DAPT) more frequently than the SCAD group (100% vs 59.3%; $P = 0.001$). However, no difference in 24-hour chest tube output was observed (375 [350–585] ml vs 430 [270–500] ml; $P = 0.96$) (FIGURE 1). The need for DAPT was the main determinant of the delay between the procedures in patients in whom the PCI-first strategy was used. Yet, among all patients who received DAPT prior to MIDCAB (40 individuals), DAPT was continued in 7 (17.5%), with no increase in postoperative bleeding (470 [450–700] ml vs 400 [300–500] ml; $P = 0.08$, for MIDCAB on DAPT vs DAPT discontinued prior to MIDCAB, respectively).

Complete revascularization was achieved in all patients. In general, post-MIDCAB cardiac troponin levels were low and similar in both groups (0.06 [0.04–0.13] µg/l vs 0.07 [0.05–0.1] µg/l [reference range <0.014 µg/l]; $P = 0.55$) (FIGURE 1). No periprocedural deaths were reported, and the observed complications included: a single case of postprocedural low cardiac output syndrome (in the SCAD group), a single case of postoperative myocardial infarction with sudden cardiac arrest and successful emergent left main / circumflex artery PCI (in the SCAD group), and a single case of pleural hematoma requiring surgical intervention (in the NSTE-ACS group). All patients remained alive at 30-day follow-up after the completion of HCR.

Previous studies on HCR showed satisfactory short- and mid-term outcomes in patients with SCAD, as compared with multivessel CABG and multivessel PCI.[4-6] Similarly, recent data from a radomized clinical trial comparing HCR, CABG, and multivessel PCI suggest that HCR may be associated with the numerically best long-term outcomes.[9] On the other hand, a proper revascularization strategy and potential benefits of complete revascularization with multivessel PCI during the index procedure in the setting of NSTE-ACS remains a matter of debate.[7] For instance, in the study by Desperak et al,[8] multivessel PCI for NSTE-ACS was independently associated with an increased incidence of nonfatal myocardial infarction and the need for ACS-driven revascularization at 12- and 36-month follow-up. However, our study is the first to report the preliminary results of using the HCR strategy for both SCAD and NSTE-ACS in patients deemed ineligible for the PCI- or CABG-only approach.

Data from our registry show that HCR may be a safe strategy to achieve complete revascularization in patients with highly complex LAD lesions and contraindications to multivessel CABG both in SCAD and NSTE-ACS. Nevertheless, the presented sample size is relatively small and did not allow us to draw firm conclusions. Further research is warranted in order to develop a proper protocol for patient selection for HCR.

ARTICLE INFORMATION

CONFLICT OF INTEREST None declared.

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