Comparison of Hybrid Coronary Revascularization Versus Coronary Artery Bypass Grafting in Patients ≥65 Years With Multivessel Coronary Artery Disease

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Hybrid coronary revascularization (HCR) combines minimally invasive left internal mammary artery−to−left anterior descending coronary artery grafting with percutaneous coronary intervention of non−left anterior descending coronary arteries. The safety and efficacy of HCR in patients ≥65 years of age is unknown. In this study, patients aged ≥65 years were included who underwent HCR at an academic center from October 2003 to September 2013. These patients were matched 1:4 to similar patients treated with coronary artery bypass grafting (CABG) using a propensity-score matching algorithm. Conditional logistic regression and Cox regression stratified on matched pairs were performed to evaluate the association between HCR and CABG, and 30-day major adverse cardiovascular and cerebrovascular events (a composite of mortality, myocardial infarction, and stroke), periprocedural complications, and 3-year all-cause mortality. Of 715 patients (143 of whom underwent HCR and 572 CABG) in the propensity score−matched cohort, rates of 30-day major adverse cardiovascular and cerebrovascular events were comparable after HCR and CABG (5.6% vs 3.8%, odds ratio 1.46, 95% confidence interval 0.65 to 3.27, $p = 0.36$). Compared with CABG, HCR resulted in fewer procedural complications (9.1% vs 18.2%, $p = 0.018$), fewer blood transfusions (28.0% vs 53.3%, $p < 0.0001$), less chest tube drainage (838 ± 484 vs 1,100 ± 579 cm^3, $p < 0.001$), and shorter lengths of stay (<5 days: 45.5% vs 27.4%, $p = 0.001$). Over a 3-year follow-up period, mortality rates were similar after HCR and CABG (13.2% vs 16.6%, hazard ratio 0.81, 95% confidence interval 0.46 to 1.43, $p = 0.47$). Subgroup analyses in high-risk patients (Charlson index ≥6, age ≥75 years) rendered similar results. In conclusion, although the present data are limited, we found that in older patients, the use of HCR is safe, has fewer procedural complications, entails less blood product use, and results in faster recovery with similar longitudinal outcomes relative to conventional CABG. **(Am J Cardiol 2014;114:224−229)**

Coronary artery bypass grafting (CABG) is increasingly performed in older patient populations at risk for in-hospital mortality or major morbidity.[1] Age-related diastolic dysfunction as a result of increased afterload due to arterial stiffness, as well as reduced functional reserve capacity, play a role in the worse outcomes in older patients.[2] The use of robotic or thoracoscopic off-pump left internal mammary artery (LIMA)−to−left anterior descending coronary artery (LAD) grafting may offer a less invasive alternative to conventional CABG, particularly when integrated with percutaneous coronary intervention (PCI) for complete revascularization.[3] However, the safety and efficacy of this integrated revascularization strategy, or hybrid coronary revascularization (HCR), have not been evaluated in older patients. To address this information gap, we conducted a study in which we assessed procedural complications, as well as 30-day and longitudinal clinical outcomes, in patients who underwent HCR versus conventional CABG.

Methods

The starting population for this analysis included the Emory University institutional Society of Thoracic Surgeons Adult Cardiac Surgery Database for all eligible cases from October 2003 to September 2013 ($n = 9{,}902$). Emory uses a custom data field to define patients on an intent-to-treat basis, in which HCR procedures involved planned LIMA-to-LAD bypass with the use of less invasive surgical techniques, combined with PCI of the remaining lesions, either performed in 1 setting or as 2 staged procedures. From this population, we excluded patients who were <65 years of age and those with clinical presentations of resuscitation or cardiogenic shock, histories of cancer (<5 years),

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See page 229 for disclosure information.

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Table 1
Baseline characteristics before and after propensity score matching

	Unadjusted			After PS Matching		
	HCR (n = 144)	CABG (n = 3,979)	Stand Diff	HCR (n = 143)	CABG (n = 572)	Stand Diff
Age (years)	74.3 ± 6.6	72.6 ± 5.7	26.4%	74.2 ± 6.5	73.9 ± 6.0	4.9%
Female	34.0%	32.6%	3.1%	33.6%	35.9%	4.9%
White	84.0%	80.1%	10.6%	83.9%	84.1%	0.5%
Body mass index (kg/m^2)	26.9 ± 4.2	28.2 ± 5.8	31.3%	26.9 ± 4.2	27.2 ± 5.1	7.0%
Diabetes	36.1%	41.4%	10.9%	36.4%	38.1%	3.5%
Hypertension	91.7%	91.0%	2.4%	91.6%	91.8%	0.6%
Cerebrovascular disease	25.0%	24.2%	4.1%	24.5%	24.5%	0.0%
Peripheral arterial disease	16.7%	19.3%	6.9%	16.8%	16.6%	0.5%
Chronic lung disease	4.9%	7.3%	11.5%	4.9%	6.5%	7.3%
Renal failure	6.3%	6.1%	0.6%	6.3%	6.5%	0.7%
Heart failure*	13.9%	24.5%	30.5%	14.0%	13.6%	1.0%
Prior myocardial infarction	55.6%	48.9%	13.3%	55.9%	56.8%	1.8%
Left ventricular ejection fraction (%)	54.5 ± 10.0	52.5 ± 12.2	20.3%	54.5 ± 10.0	54.8 ± 11.1	2.6%
Number of diseased vessels†	2.4 ± 0.5	2.7 ± 0.4	64.4%	2.4 ± 0.5	2.4 ± 0.5	2.0%
Urgent status	36.8%	45.5%	17.9%	37.1%	35.4%	3.5%

Data are presented as number and percentage or mean and standard deviation.
* Physician documentation or report of heart failure within the 2 weeks prior to admission.
† Number of diseased vessels = number of diseased major native coronary vessel systems with ≥50% narrowing of any vessel preoperatively.

Table 2
Short-term outcomes and recovery parameters

	HCR (n = 143)	CABG (n = 572)	OR (95% CI)	p-Value
Major cerebrovascular and cardiac events at 30 days	8 (5.6%)	22 (3.8%)	1.46 (0.65−3.27)	0.36
All-cause mortality	4 (2.8%)	15 (2.6%)	1.07 (0.35−3.21)	0.91
Myocardial infarction	2 (1.4%)	0 (0.0%)	—	—
Permanent stroke	2 (1.4%)	8 (1.4%)	1.00 (0.21−4.71)	1.00
Procedural complications	13 (9.1%)	104 (18.2%)	0.50 (0.28−0.89)	0.018
Renal failure	3 (2.1%)	18 (3.1%)	0.67 (0.20−2.26)	0.52
Prolonged ventilation (>24 h)	8 (5.6%)	83 (14.5%)	0.39 (0.19−0.80)	0.010
Access site infection	0 (0.0%)	8 (1.4%)	—	—
Reoperation	6 (4.2%)	33 (5.8%)	0.47 (0.31−1.74)	0.47
Bleeding events				
Coronary Artery Bypass Graft−related bleeding	10 (7.0%)	64 (11.2%)	0.63 (0.32−1.22)	0.17
Chest tube drainage (mL/24 h)	838 ± 484	1100 ± 579	$\beta = -0.18$ ($t = -4.94$)	<0.001
Need for blood transfusion	40 (28.0%)	305 (53.3%)	0.53 (0.38−0.73)	<0.001
Recovery parameters				
Post-operative length of stay <5 days	65 (45.5%)	157 (27.4%)	1.66 (1.24−2.21)	0.001
Post-operative length of stay >10 days	8 (5.6%)	85 (14.9%)	0.38 (0.18−0.78)	0.008
Discharge home	129 (90.2%)	492 (86.0%)	1.05 (0.86−1.27)	0.63

Data are expressed as mean ± standard deviation for normally distributed data or number (%) for categorical variables.

chronic illicit substance abuse, previous cardiac surgery, concomitant noncoronary surgery, single-vessel coronary artery disease, and no LIMA use. From the remaining 4,140 patients, we then matched "as treated" HCR cases to patients who underwent elective or urgent conventional CABG with or without the use of cardiopulmonary bypass. A subgroup analysis was performed in high-risk patients using Charlson co-morbidity index ≥6[4] and age ≥75 years, which are indirect indicators or surrogates for frailty status.[5−7] We also performed a sensitivity analysis, in which we matched all HCR "intention-to-treat" cases with control patients who underwent CABG.

Consideration for HCR at Emory hospitals, as well as the timing and sequence of the surgical and percutaneous components, is based on recommendations from a multidisciplinary heart team, as well as discussions with referring cardiologists and patients. Detailed information on indications and procedural information of the HCR program at Emory has been published previously.[8,9] In summary, angiographic indications for HCR include the presence of significant proximal LAD disease or left main equivalent that is amenable to LIMA-to-LAD bypass and non-LAD lesions that allow PCI. Relative clinical contraindications for HCR include hemodynamic instability, previous cardiac or thoracic surgery, severe lung disease with the inability to tolerate single-lung ventilation, and severe morbid obesity. The sequence or stages of HCR depend on various factors; the default strategy is to perform LIMA-to-LAD