Improved Outcomes of Total Arterial Myocardial Revascularization in Elderly Patients at Long-Term Follow-Up: A Propensity-Matched Analysis

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Background. **Despite the proven advantages of total arterial grafting in patients undergoing coronary artery bypass operation, its benefits in the elderly population at long-term follow-up have been widely debated to date.**

Methods. **Among 988 consecutive patients scheduled to undergo coronary artery bypass grafting operation, we performed a propensity-matched analysis in a population with double and triple vessel disease and older than 70 years and compared patients receiving total arterial grafting (G1; n = 315 patients) with conventional myocardial revascularization (left internal mammary artery on left anterior descending coronary artery plus saphenous vein grafts; G2; n = 201 patients). Two groups of 175 patients were obtained after matching. Primary end points were overall survival and survival free from cardiac-related mortality, whereas secondary end point was the occurrence of major adverse cardiovascular and cerebrovascular events (MACCEs; cardiac death, myocardial infarction, repeated revascularization on grafted vessels, stroke).**

Results. **Preoperative and intraoperative patients' characteristics were similar among the groups, as well the incidence of hospital mortality (none in both groups). At a median follow-up time of 89 months, total arterial grafting was associated with significantly improved actuarial overall survival (G1: 67.5% ± 4.6%, G2: 57.0% ± 4.4%, $p = 0.029$), survival free from cardiac-related mortality (G1: 86.9% ± 3.4%, G2: 75.9 ± 4.0%, $p = 0.02$), and occurrence of MACCEs (G1: 78.8 ± 3.9%, G2: 65.5% ± 4.4%, $p = 0.017$). Multivariate Cox regression analysis depicted conventional myocardial revascularization as an independent predictor of cardiac-related mortality (hazard ratio [HR] 2.5, 95% confidence interval [CI]: 1.3 to 4.8, $p = 0.005$) and MACCEs (HR 2.1, 95% CI: 1.2 to 3.4, $p = 0.005$).**

Conclusions. **Total arterial myocardial revascularization in elderly patients is associated with a reduced late incidence of cardiac-related mortality and major cerebral and cardiovascular events compared with the use of saphenous grafts, thereby providing improved long-term benefits also in this specific subset of patients.**

(Ann Thorac Surg 2016;■:■–■)

The long-term benefits of total arterial myocardial revascularization in the presence of multivessel coronary artery disease have been widely demonstrated over the past decade [1–4], albeit its use is mostly recommended in patients younger than 70 years also in recent international guidelines [5, 6]. In fact, there is less robust clinical evidence about the potential clinical advantage of full arterial grafting in the elderly population over the conventional technique, that is, using a single left internal mammary artery (LIMA) on the left anterior descending (LAD) coronary artery and additional saphenous vein grafts (SVGs) on the remaining target vessels.

Nevertheless, given the progressive aging and increased life expectancy of the population being referred for coronary artery bypass grafting (CABG), the identification of the most appropriate surgical revascularization strategy is of primary importance. To date, few researchers have investigated the clinical outcomes of CABG operation in an elderly population [7–10], especially when total arterial myocardial revascularization was compared with conventional CABG strategy. We therefore sought to investigate the impact of arterial revascularization in a population of patients older than 70 years and compared it with a standard technique using the LIMA on the LAD and SVGs on remaining target vessels.

Accepted for publication June 13, 2016.

Presented at the Fifty-second Annual Meeting of The Society of Thoracic Surgeons, Phoenix, AZ, Jan 23–27, 2016.

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0003-4975/$36.00
http://dx.doi.org/10.1016/j.athoracsur.2016.06.028

Patients and Methods

Study Population

Nine hundred eighty-eight consecutive patients with double and triple vessel disease were scheduled to undergo isolated CABG between July 2005 and June 2015; among them, we aimed to compare 516 patients older than 70 years and receiving either total arterial grafting (Group 1, G1; n = 315 patients) or conventional myocardial revascularization (LIMA on LAD plus SVGs; Group 2, G2; n = 201 patients).

A propensity score analysis with 1:1 matching was performed to obtain two homogeneous groups and to compare the different revascularization techniques, thus providing two comparable populations of 175 patients in each group.

Internal mammary arteries (IMAs) were harvested exclusively as skeletonized conduits in both groups; in case the target anastomosis on a non-LAD vessel on the left system was planned, the right IMA or radial artery was always connected to the left IMA in a Y or T configuration. Of note, the radial artery was in all instances procured as a pedicled conduit and left perfused in situ until the anastomosis was performed.

Total arterial revascularization strategies included the following strategies: bilateral IMA (BIMA) plus radial artery (RA), left internal thoracic artery plus RA (Y graft or RA as a free graft), or BIMA (Y graft). Of note, no right IMA was used as a free graft in the current series of patients.

Myocardial revascularization was performed either with cardiopulmonary bypass (CPB) under mild hypothermia and by means of cold crystalloid cardioplegia or with an off-pump technique (Acrobat SUV Vacuum Stabilizer; Maquet Cardiovascular, Rastatt, Germany) according to the surgeon's preference.

Exclusion criteria from patients' enrollment in the present study were concomitant procedures other than myocardial revascularization (except for concomitant surgical ablation of atrial fibrillation), single vessel disease, emergency operations, and diffuse atherosclerotic disease of the ascending aorta.

Primary end points of the study were overall survival and survival free from cardiac-related mortality, and the secondary end point was the composite occurrence of major adverse cardiovascular and cerebral events (MACCEs; defined as cardiac-related death, myocardial infarction, need for repeated percutaneous transluminal coronary angioplasty or surgical revascularization on grafted vessels, stroke).

An institutional review board approval from the University of Brescia Medical School was obtained for this retrospective study.

Patients' Follow-Up

Follow-up visits at our institution were performed at 45 days, 6 months, and on a yearly interval thereafter. Additional clinical data were collected from the referring cardiologists, general practitioners, or by telephone interview.

In case of angiography being performed over the follow-up period due to recurrence of symptoms, graft patency was defined according to the Fitzgibbon classification, that is, grade A (unimpaired graft run-off), grade B (graft caliber reduction of more than 50%), and grade C (occluded graft).

Statistical Analysis

Propensity score matching analysis allowed for adjustment of baseline patients' characteristic between the two groups (one-to-one matching based on propensity scores), as previously reported. A binary logistic regression model was used to develop a propensity score for each patient. All the baseline variables included in the propensity score model are reported in Table 1. Matching was performed with replacement and a standardized difference between unmatched and matched groups less than 0.1 was obtained. We derived propensity scores,

Table 1. Comparison of Preoperative Clinical Variables

Variable	Group 1 (n = 315)	Group 2 (n = 201)	*p* Value
Age, years			
Mean ± SD	77 ± 6	79 ± 7	0.736
Range	71–83	72–86	
EF	50.8 ± 11.0	50.9 ± 10.7	0.982
30%–50%	106 (44.0)	96 (49.5)	0.288
<30%	19 (6.8)	11 (5.5)	0.703
EuroSCORE, mean ± SD	4.7 ± 1.9	6.2 ± 1.5	0.041
Female sex	89 (28.3)	61 (30.3)	0.620
Hypertension	240 (78.7)	142 (70.6)	0.067
COPD	58 (18.4)	24 (11.9)	0.032
Dyslipidemia	185 (60.7)	117 (58.2)	0.643
Diabetes			
NIDDM	111 (37.4)	72 (37.1)	0.953
IDDM	44 (14.2)	24 (12.0)	0.507
Obesity (BMI >30)	37 (12.3)	21 (10.5)	0.571
PAD	57 (18.1)	30 (14.9)	0.399
Previous CVA	11 (3.5)	9 (4.5)	0.443
Chronic renal failure (GFR <40 mL/min)	44 (14.0)	31 (15.4)	0.701
Previous AMI	135 (44.9)	71 (35.3)	0.042
Atrial fibrillation	22 (6.9)	17 (8.5)	0.623
NYHA class III–IV	104 (34.1)	52 (26.0)	0.033
STEMI/non-STEMI <90 days	20 (6.3)	13 (6.5)	0.957
Neoplasia	24 (7.9)	13 (6.5)	0.604
Redo	26 (9.8)	8 (4.0)	0.041
Previous PCI	49 (15.5)	18 (9.0)	0.075

Values are n (%), unless otherwise indicated.

AMI = acute myocardial infarction; BMI = body mass index; COPD = chronic obstructive pulmonary disease; CVA = cerebrovascular accident; EF = ejection fraction; EuroSCORE = European system for cardiac operative risk evaluation; GFR = glomerular filtration rate; IDDM = insulin-dependent diabetes mellitus; NIDDM = non–insulin-dependent diabetes mellitus; NYHA = New York Heart Association; PAD = peripheral artery disease; PCI = percutaneous coronary intervention; SD = standard deviation; STEMI = ST elevation myocardial infarction.