Midterm angiographic follow-up after off-pump coronary artery bypass: Serial comparison using early, 1-year, and 5-year postoperative angiograms

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Objective: We analyzed the angiographic changes of the anastomotic sites at three time points for 5 years after off-pump coronary artery bypass surgery.

Methods: Of the 402 patients who underwent off-pump coronary artery bypass surgery between January 1998 and December 2001, 240 patients who received the early, 1-year, and 5-year follow-up coronary angiograms regardless of the patient's anginal symptoms were studied. Morphologic changes of grafts were traced by the FitzGibbon grading system.

Results: Overall graft patency rates (FitzGibbon grade A+B) at early, 1-year, and 5-year angiography were 98.6%, 91.9%, and 88.3%, respectively. Graft patency rates in the left anterior descending artery, left circumflex artery, and right coronary artery territories were similar at early angiograms ($P = .162$). However, graft patency rate in the left anterior descending artery territory was higher than that in the left circumflex artery and right coronary artery territories at both the 1-year ($P < .001$) and 5-year ($P < .001$) angiograms. Of the 31 FitzGibbon grade B arterial grafts (internal thoracic artery and right gastroepiploic artery) at early angiography, 10 became occluded and 19 became grade A at 5-year angiography. In the saphenous vein grafts, grade B lesions gradually increased during the 5 postoperative years (2.6% vs 6.5% vs 13.3%).

Conclusions: Midterm angiographic follow-up demonstrated acceptable patency rates of grafts after off-pump coronary artery bypass surgery. Approximately half of the FitzGibbon grade B arterial grafts in the early angiograms became grade A at 5 years after surgery, but the proportion of grade B saphenous vein grafts gradually increased over the 5 postoperative years.

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Several studies have investigated the patency rates of grafts after conventional on-pump coronary artery bypass grafting (CABG) and have shown that arterial grafts have better patency than vein grafts.[1,2] With resurgent interest in off-pump coronary artery bypass grafting (OPCAB) since the mid-1990s, there have been concerns about accuracy and patency of the grafts and the long-term outcome. Some meta-analyses demonstrated that patients undergoing OPCAB demonstrated a lower graft patency than patients undergoing conventional CABG.[3,4] Another meta-analysis[5] demonstrated a statistically insignificant benefit of conventional CABG over OPCAB for arterial graft patency. However, most of these studies were cross-sectional investigations performed at a defined point in time after surgery.

The aims of this study included (1) serial comparison of the graft patency rates in patients who had undergone angiography early postoperatively and 1 and 5 years after OPCAB, (2) evaluation of the graft patency rates based on target territories and revascularization strategies during the 5 postoperative years, and (3) assessment of the serial changes of FitzGibbon B stenotic grafts during the 5 postoperative years.

Patients and Methods

Among the total 522 patients who underwent isolated CABG between January 1998 and December 2001, OPCAB was performed in 402 (77.0%) patients. Operative mortality

Abbreviations and Acronyms

CABG = coronary artery bypass grafting
ITA = internal thoracic artery
LAD = left anterior descending coronary artery
LCX = left circumflex artery
OPCAB = off-pump coronary artery bypass grafting
RCA = right coronary artery
RGEA = right gastroepiploic artery

(≤30 days) of the OPCAB patients was 1.24% (5/402). There were 8 late in-hospital deaths (>30 days) and 16 additional deaths during the 5-year follow-up. The early, 1-year, and 5-year follow-up coronary angiograms were performed regardless of the patients' anginal symptoms in 384, 349, and 262 patients, respectively. Of the 402 OPCAB patients, 240 (59.7%) patients who received all the early (postoperative day 1.6 ± 1.6), 1-year (postoperative month 13.2 ± 5.2), and 5-year (postoperative month 59.9 ± 5.7) follow-up angiograms were studied for evaluation of the anastomotic sites and patency of the grafts (Table 1). Patients who died, refused angiographic evaluation, or had renal function impairment were excluded from the angiographic follow-up. However, patients with renal replacement therapy were included in the angiographic follow-up. Follow-up coronary angiography included 4-plane selective coronary and bypass graft angiography. One physician initially reviewed all the coronary angiograms and consensus was reached after review.

Graft patency was graded as described by FitzGibbon, Burton, and Leach[6] (grade A = excellent; grade B = fair; grade A+B = patent). Competitive graft flow was defined as distal graft as well as distal native grafted coronary artery flow not clearly opacified as seen by graft angiography, but well-visualized graft flow retrogradely as seen by native coronary angiography; it was classified as a grade B anastomosis.

The basic surgical procedures and principles of OPCAB have been previously described.[7] All patients halted aspirin therapy (300 mg/day) the day before the operation and resumed it 1 day postoperatively. The average number of distal anastomoses per patient was 3.1 ± 1.0. The grafts used for distal anastomoses were left internal thoracic artery (ITA) (n = 234), right ITA (n = 164), right gastroepiploic artery (RGEA) (n = 79), radial artery (n = 6), and saphenous vein (n = 57). Almost all of the left ITA grafts (232/234), half of the right ITA grafts (94/164), and the majority of RGEA grafts (74/79) were used as an in situ graft. The majority of ITA grafts (93.4%, 492/527) were used to revascularize the left coronary artery territory, and the majority of RGEA grafts (92.5%, 74/80) were used to revascularize the right coronary artery (RCA) territory. Saphenous vein grafts were used to revascularize the left anterior descending artery (LAD) territory (24.8%, 30/121), left circumflex artery (LCX) territory (40.5%, 49/121), and RCA territory (34.7%, 42/121) without any preference (Table 2). During the study period, we changed revascularization strategies on the basis of our early patency study after OPCAB.[8] Forty-nine (86.0%) of the 57 patients who received vein grafts underwent OPCAB before 2000, and 77.6% (142/183) of the patients who received total arterial grafts underwent OPCAB after 2000.

The operations were all performed by a single surgeon (K.-B. K.).

The study protocol was reviewed by the institutional review board and approved as a minimal risk retrospective study (Approval No. H-0701-051-196) that did not require individual consent according to the institutional guidelines for waiving consent.

TABLE 1. Preoperative characteristics and risk factors of study patients

Patient characteristics	n = 240
Sex (male/female)	158/82
Age (y)	61 ± 9
Unstable/stable angina	191/49
Risk factors, n (%)	
Hypertension	144 (60.0)
Diabetes mellitus	83 (34.6)
Hyperlipidemia	63 (23.6)
Previous PCI	28 (11.7)
History of stroke	27 (11.3)
LVEF <35%	13 (5.4)
Chronic renal failure	5 (2.1)
Urgent/emergency operation	33 (13.8)
Angiographic diagnosis, n (%)	
Three-vessel disease	148 (61.7)
Two-vessel disease	57 (23.8)
Left main disease with or without peripheral disease	64 (26.7)

PCI, Percutaneous coronary intervention; *LVEF*, left ventricular ejection fraction.

Statistical Analysis

Statistical analysis was performed with the SPSS software package (version 11.0; SPSS, Inc, Chicago, Ill). Comparison of the patency rates between the grafts was performed by the χ^2 test (Pearson χ^2 and Fisher exact tests). In the analysis of the serial changes over the 5 years' duration, nonparametric χ^2 test with McNemar examination was used. All results were expressed as mean ± standard deviation or as proportions.

TABLE 2. Grafts and their target coronary arteries

	LAD	D	RI	OM	RCA	PDA	PLB	Total
ITA	222	100	29	141	17	15	3	527
Left ITA	148	74	17	69			1	309
Right ITA	74	26	12	72	17	15	2	218
RGEA				6	13	59	2	80
Radial artery	1	2	1	4			1	9
Saphenous vein	7	23	6	43	20	19	3	121
Total	230	125	36	194	50	93	9	737

LAD, left anterior descending coronary artery; *D*, diagonal branch of the LAD; *RI*, ramus intermedius; *OM*, obtuse marginal branch of circumflex coronary artery; *RCA*, right coronary artery; *PDA*, posterior descending coronary artery; *PLB*, posterolateral branch of right coronary artery; *ITA*, internal thoracic artery; *RGEA*, right gastroepiploic artery.