Long-Term Results of the Left Anterior Descending Coronary Artery Reconstruction With Left Internal Thoracic Artery

Temucin Noyan Ogus, Murat Basaran, MD, Ozer Selimoglu, MD, Tekin Yildirim, MD, Halide Ogus, MD, Hamiyet Ozcan, MD, and Melih Hulusi Us

Cardiovascular Surgery Clinic, Goztepe Safak Hospital, Istanbul, Turkey

Background. **Recent refinements in percutaneous techniques have resulted in an increase in the numbers of patients with diffuse coronary artery disease who are referred to cardiac surgeons. Long-segmental reconstruction of the diffusely diseased left anterior descending (LAD) coronary artery with the left internal thoracic artery (LITA) has been shown to be beneficial for patients with diffuse coronary artery disease. In this retrospective study, we analyzed the long-term outcomes obtained with this technique.**

Methods. **Between April 1997 and February 2006, 3736 coronary artery bypass grafting (CABG) operations were performed by our team. Of these cases, 524 patients (14%) with the diffusely diseased LAD underwent a long-segmental reconstruction procedure with a LITA graft.**

Results. **The cohort consisted of 372 men (71%) and 152 women (29%), and the mean age was 56.5 ± 8.2 years. The mean length of the arteriotomy incision was 4.5 ± 1.2 cm (range, 2 to 10 cm). Postoperative mortality was 1.9%, and the myocardial infarction rate was 6.9%. At 3, 5, and 7 years, overall survival was 93.8% ± 0.5%, 89.6% ± 1.5%, and 85.5% ± 2.6%, and actuarial freedom from angina recurrence was 94.5% ± 1%, 88.5% ± 2%, and 82.9% ± 3%, respectively. Among survivors, interim angiographic evaluation was performed in 128 patients at a mean follow-up of 52.4 ± 13.5 months, and the patency rate of the LITA–LAD anastomosis was 91.4%.**

Conclusions. **Patients with diffuse LAD disease present a major challenge for cardiovascular surgeons. The long-term results of long-segmental LAD reconstruction are very encouraging, and this approach may be used safely in this subgroup of patients.**

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Coronary artery bypass grafting (CABG) significantly increases life expectancy [1–3], and complete myocardial revascularization should be the main goal of the surgical intervention. With the increased use of percutaneous interventions by invasive cardiologists, the number of high-risk and elderly patients referred for CABG operation has increased. Because the diffusely diseased LAD is frequently encountered in this patient population, complete myocardial revascularization may not be achieved by conventional bypass techniques.

Although coronary endarterectomy has been tried as an alternative adjunct [4–10], most surgeons are still reluctant to use this approach because of the controversial results reported in the literature. Thus, cardiac surgeons are now focused on new techniques that avoid an endarterectomy procedure or at least limit the length of the endarterectomized arterial segment.

Recently, different means of LAD reconstruction using long-segmental anastomosis techniques have been introduced in this special subgroup of patients to afford complete myocardial revascularization [11–18]. The early results suggest that these approaches are comparable with conventional bypass techniques, but only a limited number of studies have reported the clinical outcomes, patency rates, and the incidence of cardiac-related events at long-term follow-up. Furthermore, the heterogenous nature of the patient populations in different studies renders more difficult the interpretation of the results and confuses the data analysis. This retrospective study was conducted to review the long-term results obtained with extended LAD reconstruction with the left internal thoracic artery (LITA) combined with conventional CABG to other territories for diffuse coronary artery disease.

Material and Methods

Between April 1997 and February 2006, 3736 patients underwent a CABG operation, of which 524 patients (14%) had a long-segmental LAD reconstruction with the LITA. These 524 patients represent the study group for all subsequent analysis. This technique was been used in patients with multisegmental LAD involvement, at least a 1-mm LAD diameter at the preoperative angiogram, and the presence of critical but nonstenotic septal or diagonal branches, or both, along the stenotic segment. This approach was not used in patients with ulcerated and fragile atheromatous plaques to avoid plaque-related

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Address correspondence to Dr Ogus, Caferaga Mh. Bahariye C. 54/1, Kadikoy, Istanbul, Turkey; e-mail: togus@superonline.com.

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Table 1. Preoperative Characteristics of Patients

Characteristic	Value[a]
Age (years)	56.5 ± 8.2
Male sex	372 (71)
Mean weight (kg)	81.7 ± 21.5
Mean EF	0.55 ± 0.104
Poor EF (<0.35)	92 (17.5)
Mean CCSAC	2.7 ± 0.5
Stable angina	235 (45)
Unstable angina	121 (23)
Remote MI	245 (46.7)
Single-vessel disease	84 (16)
Double-vessel disease	121 (23)
Triple-vessel disease	246 (47)
Left main coronary artery stenosis	73 (14)
Antianginal medication (mean n)	2.5 ± 0.6
Hypertension	392 (74.8)
Diabetes mellitus	315 (60.1)
Smoking history	402 (76.7)
COPD	105 (20)
Hyperlipidemia	267 (51)
Atrial fibrillation	46 (8.7)
Obesity	112 (21.4)
Previous stroke	35 (6.6)
Peripheral arterial vascular disease	126 (24)

[a] Data are presented as mean ± standard deviation for continuous variables and n (%) for categoric variables.

CCSAC = Canadian Cardiovascular Society Anginal Class; COPD = chronic obstructive pulmonary disease; EF = ejection fraction; MU = myocardial infarction.

complications, and alternative techniques including endarterectomy, atherectomy, or plaque-fixation were used.

The presence of severely limited distal run-off (<1 mm) determined at the preoperative angiogram or intraoperatively usually precludes the use of an extended anastomosis technique, and these patients underwent a coronary endarterectomy procedure. The endarterectomy procedure may lead to intimal disruption and proliferation, which may influence the long-term patency rates. Therefore, the patients who required an endarterectomy were not included in the analysis to overcome any statistical bias. Redo cases and patients who had concomitant cardiac procedures were also excluded from the study protocol. This retrospective study was approved by the Ethics Committee of the institution, and informed consent was obtained from each patient.

Patient Demographics

The preoperative characteristics are listed in Table 1. The mean patient age was 56.5 ± 8.2 years (range, 41 to 82 years), and 372 (71%) were men. Mean preoperative ejection fraction was 0.55 ± 0.104 (range, 0.20 to 0.70), and 92 (17.5%) had an ejection fraction of less than 0.35. The mean preoperative Canadian Cardiovascular Society anginal class (CCSAC) was 2.7 ± 0.5. There were 236 patients (45%) with stable angina and 121 (23%) with unstable angina. Preoperative angiograms revealed single-vessel disease in 84 patients (16%), double-vessel disease in 121 (23%), triple -vessel disease in 246 (47%), and left main coronary artery stenosis in 73 (14%). The proximal LAD was totally occluded in 105 patients (20%). In the study cohort, 245 patients (46.7%) sustained a remote (>1 month) myocardial infarction (MI). All patients had been prescribed at least one antianginal medication, and the mean number was 2.5 ± 0.6 drugs per patient.

Surgical Technique

Coronary artery reconstruction was defined as performing CABG anastomosis when there were extensive atheromatous plaques downstream from the first major proximal lesion [1]. As reported by Fukui and colleagues [13], the length of a long-segment anastomosis should be at least 2 cm. Generally, the determination of multiple stenosis downstream from the first major proximal lesion at the preoperative angiogram is our indication for performing a long-segmental LAD reconstruction. In some patients, however, especially those with spiral plaques, the preoperative angiogram may not be helpful and the decision is made intraoperatively for these cases.

In 385 patients (73.5%), the operations were performed using standard cardiopulmonary bypass (CPB) techniques under moderate hypothermia (28°C). Myocardial protection was achieved with either antegrade or retrograde blood or crystalloid cardioplegia. The bypass procedure was performed with hypothermic fibrillatory arrest in 85 patients (16%), and their aortas were not cross-clamped because of severe calcification of the ascending aorta. Because the technique may be time-consuming, some patients may not tolerate the selective blood flow interruption. If we foresee during the operation that the length of the arteriotomy will exceed 3 cm, we prefer to place the patient on CPB and perform the coronary anastomoses under hypothermic fibrillatory arrest. For the remaining 54 patients (10.5%), an off-pump CABG operation was performed.

A pedicled LITA graft was used to reconstruct the LAD in all patients. A long superficial arteriotomy was made along the diseased LAD, and the length of incision was decided at the operation. The tip of the arteriotomy incision was extended to the disease-free distal portion of the vessel. The LAD was also opened proximally until the healthy part of the vessel was reached. The LAD was not opened at the level of the first proximal lesion. The LITA was then opened longitudinally, adjusting its length to the length of the LAD arteriotomy. Long-segmental LAD reconstruction was performed by covering the arteriotomy with LITA as an onlay graft by using continuous, 7-0 polypropylene suture (Fig 1). In patients who required an extended anastomosis to other myocardial territories, this technique was applied by using saphenous vein as the onlay graft. All proximal anastomoses were done while the aortic cross-clamp on.

After the operation was completed, all patients were transferred to the intensive care unit, and only acetylsalicylic acid (300 mg) was started at the first postoperative day.