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High-Risk Patients with Multivessel Disease—Is There a Role for Incomplete Myocardial Revascularization via Minimally Invasive Direct Coronary Artery Bypass Grafting?

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ABSTRACT

Background: Patients with multivessel disease with high predicted mortality for conventional coronary artery bypass grafting (CABG) and the left anterior descending coronary artery (LAD) as the major target vessel may be suitable for minimally invasive direct coronary artery bypass (MIDCAB) despite incomplete revascularization.

Methods: From January 1997 to December 2005, MIDCAB was performed in 80 patients (mean age 70 ± 11.3 years) with multivessel disease. Predicted mortality was 10.2% calculated by the logistic Euroscore. Results were analyzed retrospectively for mortality, morbidity, operation time, and event-free survival, including freedom from angina, major adverse cardiac events (MACE), and reintervention.

Results: Mean operating time was 100 ± 31 minutes. There was one in-hospital death (1.25%). Four patients (5%) had to be reoperated on, 2 via the minithoracotomy incision and 2 via sternotomy. Follow-up was completed in 87% of patients. During follow-up (26 months), 9 patients died. The cause of death was cardiac in 1 patient, noncardiac in 3 patients, and unknown in 5 patients. Two patients required reoperation because of progressive atherosclerosis, and 2 patients because of progressive valve disease. The actuarial 4-year survival was 85.6% (95% confidence interval [CI], 72%-99%) and the event-free survival including freedom from angina, MACE, and reintervention was 81.5% [95% CI, 68%-96%].

Conclusion: Incomplete revascularization via MIDCAB is a safe and effective procedure in selected patients with multivessel disease. Compared to conventional CABG in high-risk patients, MIDCAB carries a lower incidence of in-hospital death, neurological events, and perioperative myocardial infarction with comparable midterm results.

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INTRODUCTION

Complete revascularization of multivessel coronary artery disease with the left internal thoracic artery (LITA) to the left anterior descending coronary artery (LAD) and additional venous or arterial grafts to other territories represents the standard technique in coronary surgery [Calafiore 1996; Borst 1997]. For patients with multivessel disease with the LAD as the major target vessel (ie, "culprit lesion") and a high predicted mortality for coronary artery bypass grafting, a minimally invasive direct coronary artery bypass (MIDCAB) procedure may be beneficial despite incomplete revascularization. Especially in multimorbid elderly and reoperative patients, MIDCAB, by avoiding sternotomy and cardiopulmonary bypass (CPB) as well as extensive dissection of the heart and manipulation of the aorta, may present a valuable treatment alternative. Herein we review a single center experience for a concept of incomplete revascularization in patients with multivessel disease and a high risk for conventional surgery.

PATIENTS AND METHODS

From January 1997 to December 2005, 163 patients with multivessel disease were operated on through a left lateral minithoracotomy using the LITA to the LAD. Eighty-three patients underwent hybrid revascularization performed as a primary MIDCAB procedure for grafting the LAD with the LITA, followed by staged angioplasty and stenting of additional coronary lesions. The current study will focus on a group of 80 elderly and reoperative patients who were scheduled for MIDCAB whose coronary arteries other than the LAD were graded too small (<1 mm) for surgical revascularizatiuon and/or severely calcified distally or whose corresponding myocardial territories were scarred, nonviable, or aneurysmatic. These patients underwent incomplete revascularization by isolated MIDCAB without the option of angioplasty and stenting of additional coronary lesions. Demographics are given in Table 1. Multimorbid patients with severe peripheral vessel disease and chronic obstructive pulmonary disease were included. Eight patients had a malignant tumor with a decreased life expectancy. There were 54 male and 26 female patients. Forty-one patients had a

Table 1. Patient Comorbidities

	n
Diabetes mellitus (insulin dependent)	28
Chronic obstructive pulmonary disease	18
Cerebrovascular accident	8
Peripheral vascular disease	29
Malignant neoplasma	8
Age greater than 80 y	16
Previous cardiac surgery	10
Previous myocardial infarction	41
Pulmonary hypertension	5
Ejection fraction <25%	14

previous myocardial infarction. Ten patients had previously undergone surgical myocardial revascularization with venous grafts. Sixteen patients were older than 80 years. Fourteen patients had an ejection fraction less than 25%. Predicted mortality in this group of patients was 10.2% as calculated by the logistic Euroscore.

Results were analyzed for mortality, major adverse cardiac events (MACE), time of surgery, and event-free survival. According to the mandate of German healthcare policies, patients cannot be discharged early after cardiac surgery and have to stay approximately 8 days. For this reason, length of stay was not analyzed in this study.

A limitation of this paper is its retrospective nature. The study was not meant to compare different approaches for coronary artery bypass grafting (CABG) surgery, which would have required a prospective randomized study.

SURGICAL PROCEDURE

The patients were placed in a supine position with the operative site slightly elevated up to 30°. Single-lung ventilation of the right lung was applied. The fourth or fifth intercostal space was exposed through a 6- to 8-centimeter anterolateral incison, and the LITA was harvested under direct vision up to the level of the subclavian vein. Percardial tissue was opened, and the target vessel was identified. Local coronary artery occlusion was achieved by widely placing a 4-0 Prolene (Ethicon, Somerville, NJ, USA) suture proximal to the site of the anastomosis. No distal snare was applied. After heparinization, the left internal mammary artery (LIMA) to LAD anastomosis was performed using an 8-0 Prolene suture on the beating heart. Intraoperative graft flow was measured in 51 patients using transit-time Doppler. All patients were admitted to the intensive care unit and received 500 mg of aspirin immediately postoperatively.

RESULTS

Out of 80 patients who received an internal thoracic artery (ITA) to LAD bypass, 3 patients were revascularized with an additional T-graft to a diagonal branch using the radial artery. Two patients were operated on totally endoscopically using the Intuitive daVinci Telemanipulator (Intuitive Surgical, Mountain View, CA, USA).

There was 1 in-hospital death. This patient developed a massive intracerebral hemorrhage of unknown cause 5 days after surgery. Despite neurosurgical evacuation of the hematoma, the patient died 32 days after the operation. Thus, the observerd mortality was 1.25% and compared favorably to the predicted mortality of 10.2%, as calculated by the logistic Euroscore. Four patients required reoperation (5%). One patient had a stenosis of the LITA graft secondary to a clip, which was removed through the same minimally invasive access. Three other patients had a stenosis at the anastomosis requiring revision of the anastomosis. The LITA was reanastomosed to the LAD in all 3 patients, 1 through the same access and 2 via sternotomy. Mean operating time was 100 ± 31 minutes. One patient had to be reintubated and required extended ventilation time due to severe chronic obstructive pulmonary disease. The other patients were extubated after a mean of 16.5 ± 24.2 hours. In 10 patients, postoperative atrial fibrillation occured and was treated by cardioversion. Besides the massive intracerebral bleeding, no myocardial infarction or neurological event occurred, resulting in a perioperative MACE-free survival of 93.5%. A total of 36 patients had a postoperative angiography, mostly during the immediate postoperative period. Some of these angiographies were symptom-based. Thirty-one patients showed an excellent patency of the LIMA-LAD graft. All other patients were free of symptoms. During the follow-up period of 26 ± 11 months, 1 patient received a venous graft to the LAD after occlusion of the ITA graft, and 1 patient received angioplasty and stenting of the LAD. Four patients had to be reoperated on because of progressive atherosclreosis in the posterolateral vessels (2 patients) or newly diagnosed valve disease (2 patients). The LAD bypass showed excellent patency at the time of reoperation in all 4 of these patients. One of these patients received a venous graft to the circumflex artery through a lateral thoracotomy. In another patient, the aortic valve was replaced, and in a third patient a minimally invasive mitral valve repair was performed. The fourth patient underwent complete revascularization because of sustained severe symptoms of angina despite a patent LIMA graft. Three patients died because of cancer or sepsis during follow-up, 1 patient

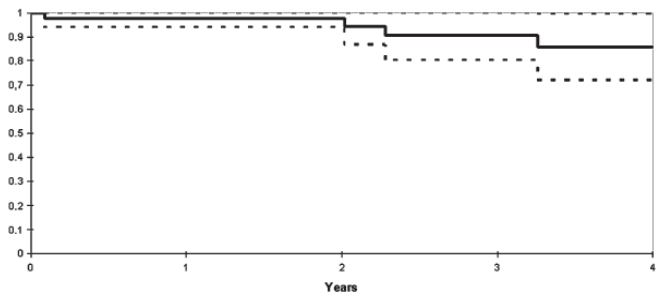

Figure 1. Actuarial survival of patients with multivessel disease treated with minimally invasive coronary artery bypass (MIDCAB) only.

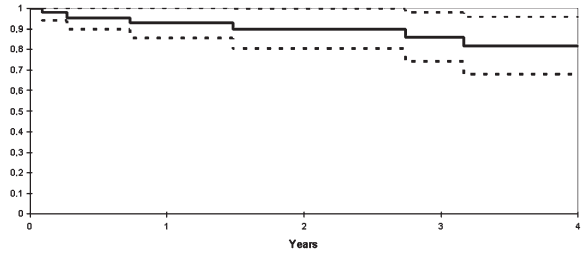

Figure 2. Actuarial event-free survival including freedom from angina, major adverse coronary events (MACE), and reintervention.

because of sudden death, and 5 for unknown reasons. One patient had recurrent angina with no surgical options for revascularization. The actuarial 4-year survival was 85.6% (95% confidence interval [CI], 72%-99%) (Figure 1), and the actuarial 4-year event-free survival including freedom from angina, MACE, and reintervention was 81.5% (95% CI, 68%-96%) (Figure 2).

DISCUSSION

MIDCAB is an accepted procedure for single-vessel disease because it is less traumatic compared to conventional CABG and provides an excellent surgical outcome [Subramanian 1997; Diegeler 2000]. By avoiding extracorporeal circulation and median sternotomy, advantages can be expected, especially in elderly patients and those with multiple comorbidities [Kahn 1992]. Patients with symptomatic cerebrovascular disease, end-stage renal failure requiring hemodialysis, peripheral vascular disease, severe mediastinal adhesions after mediastinitis, cancer with a decreased life expectancy, and chronic obstructive pulmonary disease are clearly at an increased perioperative risk. In these patients, preservation of chest integrity and avoidance of aortic clamping, manipulation of the heart, and suboptimal myocardial protection are highly desirable.

For identifying patients with multivessel disease who benefit most from MIDCAB rather than complete myocardial revascularization, functional imaging can play a critical role. Absence of late enhancement in magnetic resonance imaging (MRI) indicating nonviable myocardium can be used as a diagnostic tool to identify myocardial regions that do not profit from surgical revascularization. Figure 3 shows the late phase of a left coronary angiogram in a patient with 90% proximal LAD stenosis and occlusion of the right coronary artery. Despite the tight proximal LAD lesion, the posterior descending coronary artery is filled retrogradely and presents as a suitable target for surgical revascularization. MRI, however, demonstrates viable myocardium of the anterior wall but complete scarring of the inferior wall (Figure 4). Therefore, the patient was scheduled for MIDCAB rather than complete revascularization through a sternotmoy. The postoperative course was uneventful, and the patient was free from angina both at rest and on exertion.

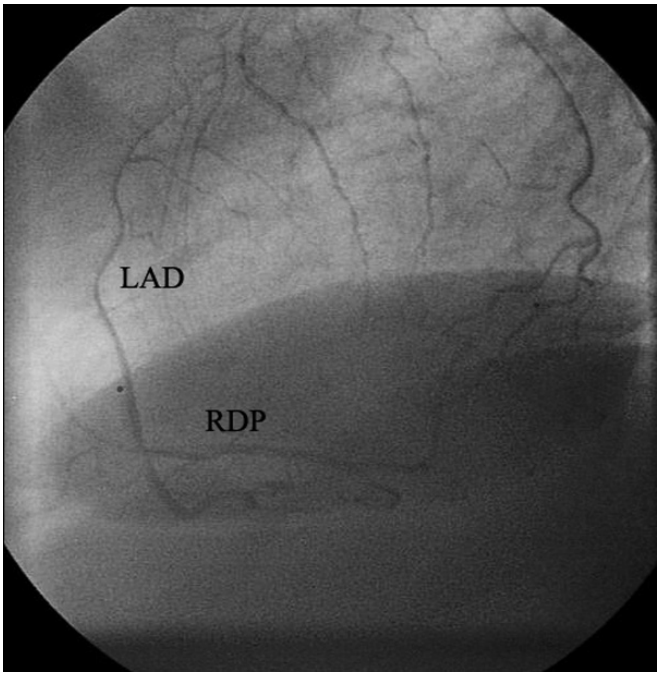

Figure 3. Angiogram of a patient with two-vessel disease (90% proximal left anterior descending coronary artery [LAD] lesion, occluded right coronary artery). Retrograde filling of the posterior descending artery (RDP), which presents as a suitable target for revascularization.

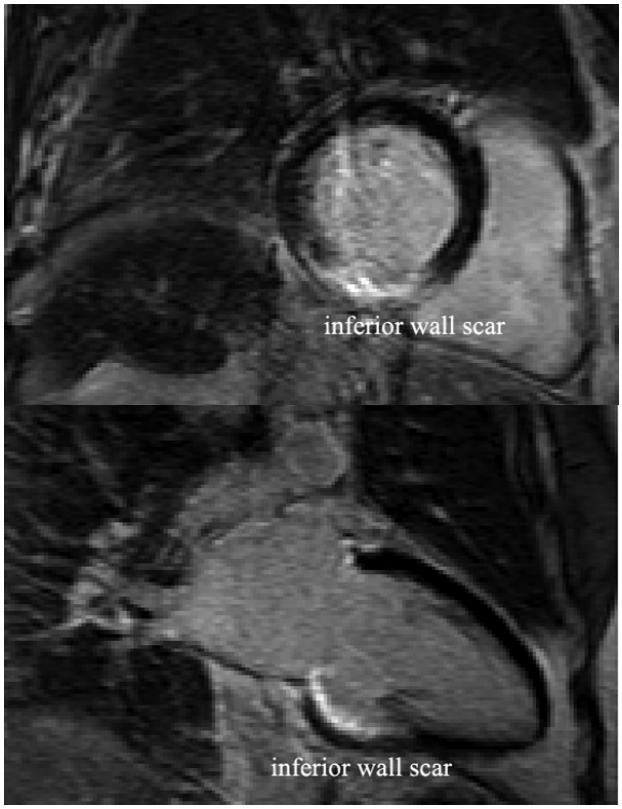

Figure 4. Magnetic resonance imaging (MRI) of the same patient showing inferior wall scar with no viable myocardium.

For conventional CABG in high-risk populations, an incidence of in-hospital death ranging from 1.3% to 6.4% and perioperative myocardial infarction rate from 1.7% to 7.3% is reported [Meharwal 2002; Gaudino 2004]. The current series of MIDCAB patients compares favorably, with a mortality of 1.25% and a myocardial infarction rate of 0%.

The principal concern of incomplete revascularization is the risk of subsequent major adverse events such as myocardial infarction, need for repeat interventions, and redo surgical treatment resulting in impaired long-term survival [Osswald 2001; Lichtenberg 2004]. In the current study, we observed no myocardial infarctions during follow-up, and only 1 patient presented with recurrence of angina. Only 2 patients required reoperation due to progression of coronary artery disease in the circumflex territory. The LAD bypass showed excellent patency at the time of reoperation in both of these patients.

The actuarial 4-year survival and event free-survival rates of 85.6% and 81.5%, respectively, are in line with the results of Calafiore et al [Calafiore 1996], who found an event-free 5-year actuarial survival of 82 ± 6% in patients with multivessel disease undergoing MIDCAB [Zimarino 2004]. Comparable to the midterm results of conventional high-risk CABG procedures [Bourassa 1992], these results confirm that the strategy of incomplete revascularization can be applied in selected high-risk patients. Functional myocardial imaging is helpful in guiding the decision process favoring MIDCAB despite incomplete revascularization.

CONCLUSION

MIDCAB grafting through a lateral ministernotomy is an established procedure to treat one-vessel disease of the LAD [Ciswski 2002; Diegeler 2002; Holzhey 2007]. The current study confirms that in selected patients with multivessel disease, MIDCAB is associated with excellent early survival and good midterm results.

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