Randomized Comparison of Minimally Invasive Direct Coronary Artery Bypass Surgery Versus Sirolimus-Eluting Stenting in Isolated Proximal Left Anterior Descending Coronary Artery Stenosis

Holger Thiele, MD,* Patrick Neumann-Schniedewind, MD,* Stephan Jacobs, MD,† Enno Boudriot, MD,* Thomas Walther, MD,† Friedrich-Wilhelm Mohr, MD,† Gerhard Schuler, MD,* Volkmar Falk, MD† Leipzig, Germany

Objectives
The purpose of this randomized study was to compare sirolimus-eluting stenting (SES) with minimally invasive direct coronary artery bypass (MIDCAB) surgery for patients with isolated proximal left anterior descending (LAD) coronary artery disease.

Background
Bare-metal stenting is inferior to MIDCAB surgery in patients with isolated proximal LAD lesions due to a higher reintervention rate with similar results for mortality and reinfarction. SES are effective in restenosis reduction.

Methods
A total of 130 patients with significant proximal LAD coronary artery disease were randomized to either SES (n = 65) or MIDCAB surgery (n = 65). The primary clinical end point was noninferiority in freedom from major adverse cardiac events (MACE), such as cardiac death, myocardial infarction, and the need for target vessel revascularization within 12 months.

Results
Follow-up was completed for all patients. MACE occurred in 7.7% of patients after stenting, as compared with 7.7% after surgery (p = 0.03 for noninferiority). The individual components of the combined end point revealed mixed results. Although noninferiority was revealed for the difference in death and myocardial infarction (1.5% vs. 7.7%, noninferiority p = 0.001), noninferiority was not established for the difference in target vessel revascularization (6.2% vs. 0%, noninferiority p = 0.21). Clinical symptoms improved significantly in both treatment groups in comparison with baseline, and the percentage of patients free from angina after 12 months was 81% versus 74% (p = 0.49).

Conclusions
In isolated proximal LAD disease, SES is noninferior to MIDCAB surgery at 12-month follow-up with respect to MACE at a similar relief in clinical symptoms. (MIDCAB Versus DES in Proximal LAD Lesions; NCT00299429) (J Am Coll Cardiol 2009;53:2324–31) © 2009 by the American College of Cardiology Foundation

Significant stenosis of the proximal left anterior descending (LAD) coronary artery has worse prognosis than lesions at other locations because of the large area of potentially jeopardized myocardium (1,2).

Established treatment options for isolated proximal LAD lesions are minimally invasive direct coronary artery bypass (MIDCAB) surgery with the left internal mammary artery (LIMA) as bypass graft and percutaneous coronary intervention (PCI) with bare-metal stents (3,4). Both treatment strategies effectively reduce symptoms (3). Randomized trials comparing both strategies revealed a significantly higher reintervention rate after stenting and similar results for mortality and reinfarction at mid- to long-term follow-up (4,5).

The application of drug-eluting stents (DES) decreased the risk of in-stent restenosis (6,7). Currently, there is only limited evidence from registries and uncontrolled trials for safety and effectiveness of DES for isolated proximal LAD coronary artery disease, as compared with MIDCAB surgery (8–11).

This randomized study was conducted to assess whether sirolimus-eluting stenting (SES) is noninferior to MIDCAB grafting in patients with isolated proximal LAD coronary artery stenosis.

Methods
Patients older than 18 years of age with isolated stenosis (>50%) of the LAD were included in this study. The lesion had to be confined to the segment between the origin of the
left circumflex coronary artery and the first major septal branch. Patients were symptomatic or myocardial ischemia had to be documented.

Exclusion criteria were acute coronary syndromes requiring immediate intervention, additional valvular heart disease requiring treatment, previous interventional or surgical treatment for coronary artery or valvular disease, severe peripheral arterial disease, significant carotid stenosis requiring treatment, renal dysfunction requiring dialysis, any diseases with limited life-expectancy, overt congestive heart failure, upper gastrointestinal bleeding <4 weeks, and contraindication to antiplatelet therapy. In addition, extreme obesity was a surgical exclusion criterion, because this precluded MIDCAB surgery. Angiographic exclusion criteria were total occlusions, involvement of the left main stem, stenosis of the first diagonal branch, intramyocardial course of the LAD, stenosis extending over a major diagonal branch (>1.5 mm), and stenosis at any other location requiring treatment.

A consensus on patient eligibility had to be obtained from both the cardiac surgeon and the cardiologist before randomization. The study was approved by the local ethics committee, and written informed consent was obtained from all patients. Balanced randomization without any stratification was performed by drawing sealed unlabeled envelopes.

PCI. Stenting was performed with the femoral approach. High-pressure direct stenting was the preferred strategy whenever feasible. Angiographic success was defined as residual stenosis <20% and Thrombolysis In Myocardial Infarction flow grade 3 without signs of dissection.

Antiplatelet therapy was started the day before stenting with aspirin (at least 100 mg/day, subsequently 100 mg/day indefinitely) and clopidogrel (600 mg orally, followed by 75 mg/day for at least 12 months). During the procedure unfractionated heparin (60 U/kg body weight) was administered. After intervention the sheath was immediately removed with subsequent use of a closure device or a compression system until hemostasis.

MIDCAB surgery. Standard surgery was performed under general anesthesia with a left anterolateral minithoracotomy (12). The LIMA was harvested under direct vision and divided distally. Local immobilization of the anastomotic site was achieved with mechanical stabilizers to allow performance of the anastomosis on the beating heart. Antiplatelet therapy consisted of aspirin 100 mg/day indefinitely.

Follow-up. All patients were monitored for at least 12 h. Creatine kinase and myocardial band activity was measured immediately after the procedure and 12 h later. A 12-lead electrocardiography was performed directly after the procedure.

The 12-month follow-up included a symptom limited exercise stress test and coronary angiography. In case of recurrence of angina and/or a positive stress test, a repeat revascularization was performed. A final telephone follow-up was conducted in June 2008 for all patients.

Angiographic analysis. Angiography at baseline and 12-month follow-up was performed in multiple projections after intracoronary nitroglycerine application. Quantitative computed analysis was performed with a validated image processing algorithm (MASS, Medis, Leiden, the Netherlands). The analysis was confined to the stented segment plus the 5-mm segments proximal and distal to the stent. Restenosis was defined as >50% diameter stenosis. In the surgical group the lumen reduction was confined to the anastomotic site; therefore, no distal reference diameter of the internal mammary artery could be obtained.

End points and definitions. The primary composite end point was defined as freedom from major adverse cardiovascular events (MACE), which included cardiovascular death, myocardial infarction, and the need for repeated target vessel revascularization within 12 months.

Secondary end points included each individual component of the composite end point and periprocedural adverse events occurring within 30 days after randomization. The clinical status was assessed according to the Canadian Cardiovascular Society classification, and physical exercise capacity was assessed by a stress test at 12-month follow-up. In addition, the quality of life was assessed by the Short Form 36 (SF-36) health survey and the MacNew Quality of Life Questionnaire, with higher scores indicating improvement (13,14).

Myocardial infarction was defined as an increase in creatine kinase-myocardial band activity 3 times the upper limit of normal after stenting and 5 times after surgery (15). In addition, standard electrocardiographic criteria were applied. The incidence of stent thrombosis was evaluated according to standard definitions (16). Repeated target vessel revascularization was defined as revascularization of the LAD comprising surgery or coronary intervention within 12 months.

Periprocedural events recorded were: 1) low output syndrome requiring intravenous inotropic agents and/or intravenous balloon counterpulsation; 2) resuscitation during revascularization; 3) cerebrovascular events (stroke, coma, or transient ischemic attack); 4) pericardial tamponade; 5) arrhythmia (ventricular fibrillation, ventricular tachycardia) requiring treatment; 6) major bleeding requiring blood transfusion; 7) rethoracotomy; 8) renal failure requiring dialysis; 9) major infections compromising post-procedural...
rehabilitation; 10) vascular access site complications (retroperitoneal hematoma, groin hematoma, aneurysm, or arterial-venous fistula) requiring surgical intervention; and 11) conversion to on-pump surgery.

All clinical outcomes were adjudicated by a clinical event committee consisting of a cardiothoracic surgeon and a cardiologist.

**Statistical analysis.** The objective of this trial was to determine whether SES was noninferior to MIDCAB. On the basis of previous reports, it was assumed that 15% of the patients treated by surgery and 10% treated by stenting would reach the primary end point (3,10,11). A sample size of 65 from surgery and 65 from stenting achieved 80% power at a 5% significance level with a 1-sided equivalence test at the maximum allowable difference of 10% between the groups (17).

Noninferiority analyses were conducted according to both the intention-to-treat and the per-protocol principles. All events occurring after randomization were included in the analysis. One-sided significance tests of noninferiority and exact 95% confidence intervals were computed for the differences in event rates between the stenting group and the surgical group, with procedures implemented in StatXact (Cytel, Inc. [2007], Cytel Studio 8.0, StatXact, Cambridge, Massachusetts) (18).

Data for categorical variables are expressed as number and percentage of patients. For continuous variables, data are reported as mean ± SD or median and interquartile range (IQR) according to their distribution. Values between groups were compared by unpaired Student t tests after testing for normal distribution; otherwise nonparametric Mann-Whitney U tests were used. Fisher exact or chi-square tests were used for categorical variables with nominal scales. Values across time were compared by paired t tests or nonparametric Wilcoxon tests. For clinical end points the Kaplan-Meier method was applied, and differences were assessed by the log-rank test. For quality of life end points, multivariate repeated measures analyses of variance were performed to compare stenting and surgery from baseline to 12-month follow-up on SF-36 and MacNew domains. All statistical tests were performed with SPSS software version 15.0 (SPSS, Chicago, Illinois). A 2-tailed p value <0.05 was considered statistically significant.

**Results**

From January 2003 to October 2007, 213 patients with isolated stenosis of the proximal LAD were screened for inclusion into the trial. Of these, 130 patients met the inclusion and exclusion criteria and were randomly assigned to stenting (n = 65) and surgery (n = 65). Reasons for noninclusion in the randomized trial are listed in Figure 1. Altogether, 19 patients refused to undergo randomization because of their stenting preference. There were no significant differences between the 2 randomized groups with respect to baseline variables or demographic data (Table 1). The median interval between randomization and treatment was 1.0 day (IQR 0.0 to 1.0 day) for patients assigned to stenting and 2.0 days (IQR 1.8 to 5.0 days) for surgery.

![Figure 1](trial_profile.png)

**Figure 1** Trial Profile

LAD = left anterior descending coronary artery.
(p < 0.001). There were no MACE while waiting for revascularization.

**Procedural outcome.** All except 2 patients in the MIDCAB group received the assigned treatment. These patients were scheduled for surgery 5 and 6 days after randomization and developed unstable angina requiring immediate treatment. Thus, they underwent otherwise uneventful SES.

In 3 stenting patients the lesion could not be crossed with the SES despite pre-dilation. Therefore, bare-metal stents with a better profile were successfully implanted. A single stent was implanted in 57 patients; 8 patients required 2 stents. The median implantation pressure was 16.0 atm (IQR 13.0 to 17.3). Further information on angiographic lesion characteristics is shown in Table 2 (19).

Bypass grafting with the LIMA was successfully performed in all patients undergoing surgery, except 1 who got a vein graft because of unsuitable arterial material. In 4 patients (6.2%) conversion to conventional sternotomy was necessary.

Periprocedural events were rare after stenting: 1 patient (1.5%) had major bleeding and 2 (3.1%) required surgery for a major hematoma and a pseudoaneurysm in the femoral artery. In contrast, periprocedural events were encountered with significantly greater frequency after surgery: n = 1 (1.5%) low output syndrome requiring intravenous inotropic agents; n = 6 (9.2%) major bleeding; n = 3 (4.6%) re-thoracotomy; n = 3 (4.6%) major infections; n = 1 (1.5%) heparin-induced thrombocytopenia type II with acute thrombosis of the aorta requiring embolectomy and subsequent amputation of the right upper limb; and n = 2 (3.1%) conversions to on-pump surgery. In total, 3.1% of patients after stenting and 16.9% after surgery had at least 1 event (p = 0.02).

The median total hospital days in the stenting group were 3 (IQR 2 to 4 days) and 13 days in the surgery group (IQR 11 to 14 days; p < 0.001), and the median hospital stay after revascularization was 1 day (IQR 1 to 1 day) versus 8 days (IQR 7 to 9 days) (p < 0.001). Discharge medication was similar with the exception of clopidogrel use (Table 1).

**Angiographic follow-up.** Angiographic follow-up within 12 months was completed in 58 stenting (89.3%) and 56 surgery (86.2%) patients (Fig. 1). Patients with and without angiographic follow-up did not differ significantly with respect to baseline characteristics. There was significant restenosis in 4 patients (6.2%) in the stenting group: 2 had focal in-stent restenosis and 2 had restenosis proximal to the stent. In all repeat revascularization was performed (n = 2 repeat PCI; n = 2 MIDCAB). Of these 4 patients with restenosis, none had received a bare-metal stent at initial intervention; repeated angiography was performed clinically driven between 6 and 7 months in 3 patients and at 12 months in 1 patient. Further information on quantitative coronary angiography is shown in Table 2. At follow-up 1 additional patient after stenting had a significant stenosis in the ostial left circumflex artery requiring intervention. As the left main was involved, kissing balloon angioplasty was performed although the stent in the LAD did not show significant restenosis.

After surgery no graft was totally occluded; 5 grafts showed a stenosis of >50% to 4 located at the distal anastomosis and 1 in the proximal portion of the LIMA (Table 2). However, none needed repeated revascularization; in 3 the stenosis was between 50% and 60%, and in 2 the higher-grade stenosis did not result in ischemia assessed by treadmill ergometry and single-photon-emission computed tomography.

**Follow-up.** At 12-month follow-up the combined clinical end point occurred by intention-to-treat in 7.7% of patients after stenting and in 7.7% after surgery (Table 3). The difference in the event rates was 0 and satisfied statistical criteria for noninferiority (upper bound 8.6%, p = 0.03 for noninferiority). In a per-protocol analysis the difference in the event rates was 0.2%, and this also satisfied the criteria for noninferiority (upper bound 8.3%, p = 0.03 for noninferiority) (Table 3).

One patient had acute stent thrombosis after stenting, presumably a result of residual dissection with subsequent recanalization and implantation of an additional SES; 5 patients (7.7%) had perioperative infarction after surgery. In none was there an occluded bypass graft. However, in 2 patients the proximal LAD was newly occluded, which might have resulted in infarction due to side branch occlusion, and in 1 patient there was a kinking stenosis of the proximal bypass post-operatively, which disappeared at 12 month follow-up. In 2 patients no causal reason for infarction could be detected. There were no cardiac deaths. Individual components of the combined end point revealed

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Patient Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>Stenting (n = 65)</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>66 (59–72)</td>
</tr>
<tr>
<td>Male sex</td>
<td>45 (69)</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>28.0 ± 3.7</td>
</tr>
<tr>
<td>Cardiovascular risk factors</td>
<td></td>
</tr>
<tr>
<td>Current smoking</td>
<td>9 (14)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>54 (83)</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>36 (55)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>18 (28)</td>
</tr>
<tr>
<td>Previous myocardial infarction</td>
<td>15 (23)</td>
</tr>
<tr>
<td>Q-wave infarction</td>
<td>4 (6)</td>
</tr>
<tr>
<td>Non-Q-wave infarction</td>
<td>11 (17)</td>
</tr>
<tr>
<td>Previous stroke</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Left ventricular ejection fraction (%)</td>
<td>65 (60–66)</td>
</tr>
<tr>
<td>Cardiovascular discharge medication</td>
<td></td>
</tr>
<tr>
<td>Aspirin</td>
<td>65 (100)</td>
</tr>
<tr>
<td>Clopidogrel</td>
<td>65 (100)</td>
</tr>
<tr>
<td>Beta-blocker</td>
<td>64 (99)</td>
</tr>
<tr>
<td>ACE-inhibitor/AT-1–antagonist</td>
<td>65 (100)</td>
</tr>
<tr>
<td>Statins</td>
<td>64 (99)</td>
</tr>
</tbody>
</table>

Values are mean ± SD, median (interquartile range), or n (%). ACE = angiotensin-converting enzyme; AT = angiotensin; MIDCAB = minimally invasive direct coronary artery bypass grafting.
mixed results. Although noninferiority was revealed for the difference in myocardial infarction, noninferiority was not established for the difference in repeated target vessel revascularization (Table 3).

At a median follow-up time of 43 months (IQR 21 to 55 months) after stenting and 41 months (IQR 21 to 51 months) after surgery, there was also no difference in the combined clinical end point (Fig. 2). There was 1 noncardiac death after stenting (pancreatic cancer 14 months after randomization) and 2 after surgery (prostate cancer 15 months and suicide 11 months after randomization).

Clinical symptoms, exercise capacity, and quality of life. After stenting the median Canadian Cardiovascular Society class improved from 3.0 (IQR 2.0 to 3.0) to 0.0 (IQR 0.0 to 1.0; p < 0.001) with 81% of patients free from angina. Similar results were observed after MIDCAB (3.0 [IQR 2.0 to 3.0] to 0.0 [IQR 0.0 to 2.0]; p < 0.001 vs. baseline; p = 0.10 vs. stenting) with 74% free of angina (p = 0.49 vs. stenting). Physical work capacity on a bicycle ergometer or treadmill was similar in both groups (stenting: 140 W [IQR 100 to 177 W]; surgery: 125 W [IQR 100 to 150 W; p = 0.17]).

The treatment effect of stenting and surgery on changes in perceived quality of life from baseline to 12-month follow-up is displayed in Table 4. There were no significant differences in SF-36 and MacNew domains between stenting and surgery at follow-up, adjusted for baseline. However, patients after both stenting and surgery showed significant improvements from baseline to follow-up in all domains.

Discussion

This trial demonstrates that, at mid-term follow-up, SES is noninferior to MIDCAB surgery for patients with isolated proximal LAD stenosis. At the same time there were less periprocedural adverse events, owing to the less invasive approach of stenting. In addition, the relief of symptoms and the quality of life were similar between both reperfusion regimens.
In previous trials, bare-metal stenting and MIDCAB showed similar results with respect to death and mortality at a significantly higher rate of repeated revascularization after stenting (3,4). Restenosis has been addressed by the use of DES (6,7). However, as shown in the recent trial, the restenosis rate is not 0 and therefore did not satisfy the criteria for noninferiority. The restenosis rate is similar to registries, uncontrolled trials, and subgroups of randomized trials, where the target vessel revascularization rate of the proximal LAD ranged from 0% to 7.9% with sirolimus- or paclitaxel-eluting stents (8–11). Whereas proximal stenosis location in the LAD was a predictor of restenosis in the bare-metal stenting era, this location now has no increased risk for restenosis in comparison with lesions at any other location (3,20). Late lumen loss was 0.2 mm in the current trial, which is similar to the rate observed in previous SES trials and might be a reason why SES are superior for the prevention of restenosis compared with paclitaxel-eluting stents, particularly in lesions with a high risk of restenosis (21–23).

After surgery the rate of repeat revascularization, in contrast to stenting, was 0 in the current trial and 2% to 10% in previous trials, which underlines the well-known patency of LIMA grafts (3–5,8,24).

Stent thrombosis is a potentially important limitation of DES. However, whereas restenosis usually has a relatively benign clinical outcome, stent thrombosis is associated with an increased risk of myocardial infarction and a high mortality (25). This persistent, potentially prothrombotic substrate necessitates prolonged dual antiplatelet medication for at least 12 months as recommended in the current trial (26).

New, more potent antiplatelets will partially overcome this problem; however, these have not been tested extensively (27). The minimally invasive surgical approach has been developed to minimize surgical trauma by limiting the access to the heart and avoiding cardiopulmonary bypass. Despite the more challenging access, patency rates similar to conventional bypass grafting have been reported (3). However, this approach is associated with a small but consistent rate of perioperative complications (3,12,28), like in conventional surgery. Perioperative complications occurred significantly more often after surgery and had substantial impact on hospital resources. However, these complications did not influence quality of life at 12-month follow-up and the overall rate of MACE.

Perioperative infarction has been observed in 7.7% of patients in the MIDCAB group, which is slightly higher compared with previous trials (0% to 4%) (4), despite the use of a more conservative definition of myocardial infarction (15). This is somewhat surprising, because all grafts proved to be patent, and this accounted for the high MACE rate in the surgery group. In contrast, the rates for mortality and target vessel revascularization were slightly lower compared with previous trials, which is attributed to the long-term patency rate of the LIMA (29,30).

Another important aspect is patient preference. Many patients refused to participate because of preference for stenting, which is the only true minimally invasive approach. In addition, no patients were excluded from stenting due to angiographic reasons or any comorbidity, in contrast to surgery.
The lack of a more long-term follow-up might be a limitation of this study, because the benefits of either revascularization strategy might emerge beyond 1 year. However, previous randomized trials did not find relevant differences at long-term follow-up for hard end points in patients receiving bare-metal stents (5). Furthermore, at a median follow-up of 42 months there were no differences in the current trial. Another caveat was that the results were obtained only at a single highly-experienced tertiary care center. Thus, the results might not be generalized. Due to the design of the trial no blinding was possible.

**Conclusion**

In patients with isolated proximal LAD coronary artery disease, SES is noninferior to MIDCAB surgery at 12-

---

**Table 4** Changes in Quality of Life From Baseline to Follow-Up in the Stenting and Surgery Group, Assessed by SF-36 and MacNew

<table>
<thead>
<tr>
<th></th>
<th>Stenting (n = 65)</th>
<th>MIDCAB (n = 63)</th>
<th>Group Comparison*</th>
<th>Time Comparison*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Follow-Up</td>
<td>Baseline</td>
<td>Follow-Up</td>
</tr>
<tr>
<td>Physical functioning (range 8–24)</td>
<td>17.1 ± 4.1</td>
<td>19.3 ± 4.0</td>
<td>17.1 ± 4.5</td>
<td>19.8 ± 4.0</td>
</tr>
<tr>
<td>Role physical (range 4–20)</td>
<td>12.2 ± 4.8</td>
<td>14.4 ± 3.9</td>
<td>13.3 ± 3.9</td>
<td>14.2 ± 4.1</td>
</tr>
<tr>
<td>Bodily pain (range 2–12)</td>
<td>7.2 ± 2.6</td>
<td>9.6 ± 2.5</td>
<td>6.9 ± 2.5</td>
<td>9.3 ± 2.4</td>
</tr>
<tr>
<td>General health (range 5–25)</td>
<td>15.7 ± 3.3</td>
<td>17.3 ± 3.5</td>
<td>16.2 ± 3.4</td>
<td>17.6 ± 3.2</td>
</tr>
<tr>
<td>Vitality (range 4–20)</td>
<td>11.8 ± 3.3</td>
<td>12.9 ± 3.3</td>
<td>12.0 ± 2.8</td>
<td>13.2 ± 3.2</td>
</tr>
<tr>
<td>Social functioning (range 2–10)</td>
<td>8.0 ± 2.1</td>
<td>8.6 ± 1.6</td>
<td>7.7 ± 1.9</td>
<td>8.6 ± 1.7</td>
</tr>
<tr>
<td>Role emotional (range 3–15)</td>
<td>10.4 ± 4.0</td>
<td>11.5 ± 2.9</td>
<td>10.5 ± 3.2</td>
<td>11.5 ± 3.1</td>
</tr>
<tr>
<td>Mental health (range 5–25)</td>
<td>17.8 ± 4.0</td>
<td>18.7 ± 3.3</td>
<td>17.7 ± 3.4</td>
<td>18.7 ± 3.7</td>
</tr>
<tr>
<td>MacNew</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotional (range 1–7)</td>
<td>4.9 ± 1.0</td>
<td>5.4 ± 0.9</td>
<td>4.8 ± 1.1</td>
<td>5.4 ± 1.1</td>
</tr>
<tr>
<td>Physical (range 1–7)</td>
<td>4.9 ± 1.1</td>
<td>5.7 ± 0.9</td>
<td>4.8 ± 1.1</td>
<td>5.6 ± 1.0</td>
</tr>
<tr>
<td>Social (range 1–7)</td>
<td>5.2 ± 1.1</td>
<td>5.8 ± 0.9</td>
<td>5.1 ± 1.1</td>
<td>5.7 ± 1.1</td>
</tr>
<tr>
<td>Total (range 1–7)</td>
<td>4.9 ± 1.0</td>
<td>5.5 ± 0.9</td>
<td>4.8 ± 1.0</td>
<td>5.5 ± 1.0</td>
</tr>
</tbody>
</table>

*Results of repeated measures analysis of variance testing between-subject (group) and within-subject (time) factors. MIDCAB = minimally invasive direct coronary artery bypass grafting; SF-36 = Short Form 36.
month follow-up with respect to freedom from MACE with similar relief of symptoms and fewer periprocedural complications.

Acknowledgment
The authors thank Dr. Goetz Gelbrich, PhD, Biometrician, Coordination Center for Clinical Trials Leipzig, Germany, for assistance with statistical analyses.

Reprint requests and correspondence: Dr. Holger Thiele, Department of Internal Medicine/Cardiology, University of Leipzig–Heart Center, Strümpellstrasse 39, 04289 Leipzig, Germany. E-mail: thielh@medizin.uni-leipzig.de.

REFERENCES

Key Words: atherosclerosis • bypass • coronary artery disease • drug-eluting stents • restenosis.