Long-Term Survival After Off-Pump Coronary Artery Bypass Surgery: A Swedish Nationwide Cohort Study

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Background. The aim of this study was to analyze long-term survival after primary isolated off-pump coronary artery bypass grafting (CABG) compared with on-pump CABG in a nationwide patient cohort.

Methods. Patients who underwent primary isolated nonemergent CABG in Sweden between 1998 and 2008 were identified. Swedish registers were used to gather patient data and outcomes. Multivariable regression models were used to estimate the association between off-pump CABG and early mortality, long-term survival, and a composite of death from any cause or rehospitalization for myocardial infarction, heart failure, or stroke. Similar analyses were repeated in a propensity score-matched cohort.

Results. The study included 50,676 patients, and 3,337 (6.6%) underwent off-pump CABG. In the adjusted analyses, off-pump CABG was not associated with better survival compared with on-pump CABG in the overall cohort (hazard ratio [HR] for death: 0.99, 95% confidence interval [CI]: 0.92 to 1.06) or in the matched cohort (HR: 1.02, 95% CI: 0.91 to 1.16). The results were similar for early mortality (odds ratio: 1.25, 95% CI: 0.95 to 1.65), and the composite endpoint (HR: 0.99, 95% CI: 0.94 to 1.05).

Conclusions. Long-term survival was similar between off-pump and on-pump CABG in patients undergoing non-emergent primary isolated CABG in Sweden from 1998 to 2008. Off-pump CABG was performed infrequently and there was a continuous decline in the number of procedures during the study period.

Off-pump techniques in coronary artery bypass grafting (CABG) were developed in order to reduce morbidity and mortality associated with the use of cardiopulmonary bypass. Observational studies have suggested that the avoidance of cardiopulmonary bypass reduces morbidity and mortality [1, 2]. There are mixed findings in meta-analyses [3, 4] and randomized controlled trials have not supported the results in the early observational studies [5–8]. Although several studies have investigated the short-term outcomes after off-pump CABG, a limited number of studies have assessed long-term outcomes [9, 10]. Off-pump CABG is technically more demanding than on-pump CABG and has been associated with poorer 1-year graft patency [5]. Mortality was higher after off-pump CABG than on-pump CABG in patients followed for 5 years and longer [9]. The risk is higher at centers with a low volume of off-pump procedures [11]. Only a small proportion of CABG procedures in Sweden have been performed off-pump and the long-term outcomes have not been assessed. The long-term survival after off-pump CABG in a large unselected patient population where off-pump CABG is performed infrequently has not been reported.

We performed a nationwide population-based cohort study to investigate long-term survival after off-pump CABG in Sweden from 1998 to 2008. The primary aim was to analyze the association between off-pump CABG and long-term survival in patients who underwent primary isolated non-emergent CABG. A secondary objective was to study the association between off-pump CABG and a composite endpoint of death from any cause or rehospitalization for myocardial infarction, heart failure, or stroke. We also investigated early outcomes and off-pump use by year and region in Sweden during the study period.

Patients and Methods

Design

We conducted a nationwide population-based cohort study. The study was approved by the regional Human Research Ethics Committee, Stockholm, Sweden.

Study Population

We identified all patients who underwent CABG in Sweden between 1998 and 2008 from the Swedish Web-system
for Enhancement and Development of Evidence-based care in Heart Disease Evaluated According to Recommended Therapies (SWEDHEART) register [12].

Data Sources

The Swedish unique personal identity number [13] was used by the National Board of Health and Welfare to retrieve information from the national registers to assemble the study database. Baseline patient characteristics were obtained from SWEDHEART and the Swedish National Patient Register (Swedish National Board of Health and Welfare) [14, 15].

Outcome Measures

The primary outcome measure was all-cause mortality. Secondary outcome measures included early mortality, defined as death within 30 days from surgery, and a composite endpoint of death from any cause; rehospitalization for myocardial infarction, heart failure, or stroke. Survival status was ascertained in February 2011 using the previously mentioned national registers [13] and the continuously updated Total Population Register at Statistics Sweden. Follow-up regarding myocardial infarction, heart failure, and stroke ended on December 31, 2008.

Statistical Analysis

The study database was created by the Swedish National Board of Health and Welfare by linking information in the mentioned national registers using the Swedish personal identity number [13] and the continuously updated Total Population Register at Statistics Sweden. Baseline patient characteristics were used by the National Board of Health and Welfare to obtain information from the national registers to assemble the study database. Baseline patient characteristics were used by the National Board of Health and Welfare to retrieve information from the national registers to assemble the study database. Baseline patient characteristics were obtained from SWEDHEART and the Swedish National Patient Register (Swedish National Board of Health and Welfare) [14, 15].

Results

Study Population and Baseline Characteristics

From the SWEDHEART register, we identified 62,904 adult patients who underwent CABG between January 1998 and December 2008. We excluded 1,169 patients who had previous cardiac surgery, 8,758 patients who had CABG patient to 1 on-pump CABG patient, in which the propensity score differed by no more than 0.001. We estimated standardized differences for variables after matching to investigate post-match balance. Standardized differences less than 10% are generally considered a small and acceptable imbalance. In the matched cohort, we used conditional logistic regression to assess the association between off-pump CABG use and early mortality, and Cox proportional hazards regression stratified based on matched pairs for the estimation of HRs for long-term survival and the composite endpoint of rehospitalization or death. Stata version 12.1 (StataCorp LP, College Station, TX) was used for all analyses. Supplementary Methods are provided in the Appendix.

Table 1. Baseline Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All Patients</th>
<th>On-Pump CABG</th>
<th>Off-Pump CABG</th>
<th>p Valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>50,676</td>
<td>47,339</td>
<td>3,337</td>
<td></td>
</tr>
<tr>
<td>Percent of study population</td>
<td>100</td>
<td>93</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Age, mean (SD), years</td>
<td>66.7 (9.3)</td>
<td>66.8 (9.3)</td>
<td>65.3 (10)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Female sex (%)</td>
<td>22</td>
<td>22</td>
<td>26</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Estimated GFR, mean (SD), mL/min/1.73 m²</td>
<td>75 (21)</td>
<td>75 (21)</td>
<td>72 (21)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diabetes mellitus (%)</td>
<td>23</td>
<td>23</td>
<td>18</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hypertension (%)</td>
<td>56</td>
<td>56</td>
<td>44</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hyperlipidemia (%)</td>
<td>58</td>
<td>58</td>
<td>52</td>
<td>0.006</td>
</tr>
<tr>
<td>Peripheral vascular disease (%)</td>
<td>8</td>
<td>8</td>
<td>10</td>
<td>0.001</td>
</tr>
<tr>
<td>Current smoking (%)</td>
<td>19</td>
<td>19</td>
<td>21</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease (%)</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>0.598</td>
</tr>
<tr>
<td>Prior myocardial infarction (%)</td>
<td>44</td>
<td>44</td>
<td>39</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Prior stroke (%)</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>0.001</td>
</tr>
<tr>
<td>Heart failure (%)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>0.495</td>
</tr>
<tr>
<td>Left ventricular function</td>
<td>Ejection fraction &gt;0.50 (%)</td>
<td>73</td>
<td>73</td>
<td>75</td>
</tr>
<tr>
<td>Ejection fraction 0.30-0.50 (%)</td>
<td>24</td>
<td>24</td>
<td>21</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ejection fraction &lt;0.30 (%)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0.116</td>
</tr>
<tr>
<td>Surgery within 7 days of decision (%)</td>
<td>28</td>
<td>29</td>
<td>19</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

a χ² test or t test.

CABG = coronary artery bypass grafting; GFR = glomerular filtration rate.
another cardiac procedure in addition to CABG, and 2,301 patients who underwent emergency surgery, defined as surgery within 24 hours of decision. The final study population consisted of 50,676 patients who underwent primary isolated non-emergent CABG. In total, 3,337 patients (6.6%) had off-pump CABG and 47,339 had on-pump CABG. Patient characteristics differed in the 2 groups (Table 1). Ninety-three percent of the patients received an internal mammary artery graft but fewer grafts per patient were inserted in the off-pump group (Table 2).

Follow-Up and Early Outcomes
The total follow-up time was 362,254 patient-years (mean 7.1 years). During follow-up, 819 (25%) patients in the off-pump CABG group died compared with 10,707 (23%) patients in the on-pump CABG group. Early mortality did not differ and was 1.7% (58 of 3,279) in the off-pump CABG group and 1.4% (677 of 46,662) in the on-pump CABG group. There was no significant association between off-pump CABG use and early mortality (unadjusted OR 1.22, 95% CI: 0.93 to 1.60). The EuroSCORE-adjusted OR was 1.29 (95% CI: 0.95 to 1.65). Reoperation for sternal wound complications (adjusted OR: 2.36, 95% CI: 2.09 to 2.66), reoperation for bleeding (adjusted OR: 1.86, 95% CI: 1.66 to 2.08), and postoperative stroke (adjusted OR: 2.32, 95% CI: 2.06 to 2.62) were more common in the off-pump than in the on-pump group (Table 2).

Off-Pump CABG and Late All-Cause Mortality
The crude and multivariable adjusted associations between off-pump CABG and all-cause mortality are shown in Table 3. Off-pump CABG was significantly associated with crude all-cause mortality (HR: 0.92; 95% CI: 0.85 to 0.98) compared with on-pump CABG. The overall survival at 10 years was 73% (95% CI: 72 to 75) in the off-pump CABG group and 71% (95% CI: 70 to 71) in the on-pump CABG group (p = 0.017) (Fig 1; Supplementary Table 1).

Age- and gender-adjusted mortality was similar in the off-pump CABG and on-pump CABG groups (HR: 1.02, 95% CI: 0.95 to 1.10). In the multivariable model, off-pump CABG was not associated with mortality (HR: 0.99, 95% CI: 0.92 to 1.06) compared with on-pump CABG.

<table>
<thead>
<tr>
<th>Variable</th>
<th>On-Pump CABG</th>
<th>Off-Pump CABG</th>
<th>p Valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>47,339</td>
<td>3,337</td>
<td></td>
</tr>
<tr>
<td>Number of deaths (%)</td>
<td>10,707 (23)</td>
<td>819 (25)</td>
<td></td>
</tr>
</tbody>
</table>

CABG = coronary artery bypass grafting; CI = confidence interval.

Table 3. Crude and Multivariable Adjusted Association Between Off-Pump CABG and All-Cause Mortality in 50,676 Patients Who Underwent Nonemergent Primary Isolated CABG From 1998 to 2008 in Sweden

95% CI: 0.95 to 1.10). In the multivariable model, off-pump CABG was not associated with mortality (HR: 0.99, 95% CI: 0.92 to 1.06) compared with on-pump CABG.

Off-Pump CABG and the Composite Endpoint of All-Cause Mortality or Rehospitalization
The composite endpoint all-cause mortality or rehospitalization for myocardial infarction, heart failure, or stroke occurred in 1,280 (38%) patients in the off-pump CABG group, compared with 16,625 (35%) in the on-pump CABG group. Freedom from the composite endpoint at 10 years was 49% (95% CI: 47 to 52) in the off-pump CABG group and 44% (95% CI: 43 to 45) in the on-pump CABG group (p = 0.021) in the overall cohort (Fig 2; Supplementary Table 2). The crude and multivariable adjusted associations between off-pump CABG use and the composite endpoint of all-cause mortality or rehospitalization are shown in Table 4. In the final multivariable model, off-pump CABG was not associated with an increased risk of death or rehospitalization (HR: 0.99, 95% CI: 0.94 to 1.05) compared with on-pump CABG.

Table 2. Perioperative Data in Patients Who Underwent On-Pump and Off-Pump CABG

<table>
<thead>
<tr>
<th>Variable</th>
<th>All Patients</th>
<th>On-Pump CABG</th>
<th>Off-Pump CABG</th>
<th>p Valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of grafted coronary arteries, mean (SD)</td>
<td>3.4 (1.0)</td>
<td>3.5 (1.0)</td>
<td>2.0 (1.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Internal mammary artery use (%)</td>
<td>93</td>
<td>93</td>
<td>93</td>
<td>0.693</td>
</tr>
<tr>
<td>Radial artery used (%)</td>
<td>3.5</td>
<td>3.2</td>
<td>7.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Acute perioperative kidney injury (%)</td>
<td>13</td>
<td>13</td>
<td>17</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Postoperative stroke (%)</td>
<td>5.0</td>
<td>4.6</td>
<td>10</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Re-exploration for bleeding (%)</td>
<td>6.9</td>
<td>6.5</td>
<td>12</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Reoperation for sternal wound complications (%)</td>
<td>4.9</td>
<td>4.5</td>
<td>10</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Death within 30 days from surgery (%)</td>
<td>1.4</td>
<td>1.4</td>
<td>1.7</td>
<td>0.150</td>
</tr>
</tbody>
</table>

a Chi-square test or t test.

Acute perioperative kidney injury was defined as a >0.3 mg/dL (26 μmol/L) increase in postoperative creatinine values.

CABG = coronary artery bypass grafting.
Time Trends in Off-Pump CABG in Sweden Between 1998 and 2008
The total number of CABG performed and the proportion of off-pump CABG decreased during the study period. After a peak at 16% in year 2000, only 1% of all CABG was performed off-pump in 2008 (Supplementary Table 3). The use of off-pump CABG varied between 3% and 11% among the 8 cardiac surgery centers in Sweden (Supplementary Table 4).

Outcomes in the Propensity Score-Matched Cohort
By using propensity score matching methods, a satisfactory balance regarding baseline characteristics was achieved between the 2 treatment groups. There was no significant association between off-pump CABG and early mortality (OR: 1.30, 95% CI: 0.83 to 2.05), reoperation for sternal wound complications (OR: 0.98, 95% CI: 0.82 to 1.17), reoperation for bleeding (OR: 1.00, 95% CI: 0.85 to 1.19), or postoperative stroke (OR: 1.05, 95% CI: 0.88 to 1.25) in the matched cohort.

All-Cause Mortality in the Matched Cohort
Survival at 10 years was similar between the off-pump and on-pump CABG groups (73% vs 72%, p = 0.56) in the propensity score-matched cohort (Supplementary Figure 1; Supplementary Table 1). There was no significant association between off-pump CABG and long-term survival (HR: 1.02, 95% CI: 0.91 to 1.16).
Table 4. Crude and Multivariable Adjusted Association Between Off-Pump CABG and a Composite Endpoint of Death or Rehospitalization for Myocardial Infarction, Heart Failure, or Stroke in 50,676 Patients Who Underwent Primary Isolated Nonemergent CABG From 1998 to 2008 in Sweden

<table>
<thead>
<tr>
<th>Variable</th>
<th>On-Pump CABG</th>
<th>Off-Pump CABG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>47,339</td>
<td>3,337</td>
</tr>
<tr>
<td>Number of events (%)</td>
<td>16,625 (35)</td>
<td>1,280 (38)</td>
</tr>
<tr>
<td>Hazard ratio (95% CI)</td>
<td>1.00 (0.96 – 0.99)</td>
<td>1.08 (1.05 – 1.10)</td>
</tr>
</tbody>
</table>

* Reference category.  
* Multivariable adjustment was made for age, gender, estimated glomerular filtration rate, left ventricular ejection fraction, diabetes mellitus, chronic obstructive pulmonary disease, peripheral vascular disease, preoperative myocardial infarction, stroke, heart failure, perioperative acute kidney injury, and the use of an internal mammary artery.

CABG = coronary artery bypass grafting  
CI = confidence interval.

Composite Endpoint of All-Cause Mortality or Rehospitalization in the Matched Cohort

Freedom from the composite endpoint of all-cause mortality or rehospitalization for myocardial infarction, heart failure, or stroke at 10 years was comparable between the off-pump and on-pump CABG groups (49% vs 43%, p = 0.22) in the propensity score-matched cohort (Supplementary Figure 2 and Supplementary Table 2). There was no significant association between off-pump CABG and the composite endpoint all-cause mortality or rehospitalization (HR: 0.99, 95% CI: 0.90 to 1.10).

Comment

We found that off-pump CABG was associated with similar long-term survival and freedom from the composite endpoint of death from any cause or rehospitalization for myocardial infarction, heart failure, or stroke compared with on-pump CABG in patients undergoing non-emergent primary isolated CABG in Sweden from 1998 to 2008. The results were similar after propensity score matching. Off-pump CABG was performed infrequently and there was a continuous decline in the number of procedures performed in Sweden during the study period.

These results are in line with prior randomized controlled trials suggesting similar outcomes after off-pump and on-pump CABG. In the CABG Off or On Pump Revascularization Study, 4,752 patients were randomized to off-pump or on-pump CABG with no differences in the combined endpoint of death, myocardial infarction, stroke, or renal replacement therapy at 30 days (9.8% vs 10.3%) [6] and 1 year (12.1% vs 13.3%) [7]. In the German Off-Pump Coronary Artery Bypass Grafting in Elderly Patients trial, 2,539 patients over the age of 75 were randomized to off-pump or on-pump CABG [8]. At 30 days and 1 year, there was no difference in the composite outcome of death, myocardial infarction, stroke, repeat revascularization, or renal replacement therapy (7.8% vs 8.2% and 13.1% vs 14.0%, respectively). The Randomized On/Off Bypass trial showed no difference between off-pump and on-pump CABG in death or major complications at 30 days (7.0% vs 5.6%) but a higher rate of death, myocardial infarction, or revascularization at 1 year in the off-pump group (9.9% vs 7.4%) [5]. A recent meta-analysis incorporating 59 randomized trials and 8,961 patients showed no difference in death or myocardial infarction after off-pump or on-pump CABG; however, off-pump CABG was associated with a reduced risk of stroke [4].

Higher frequency of repeat revascularization after off-pump compared with on-pump CABG has been reported [6–8]. Graft patency is associated with long-term outcomes [17] and it has been hypothesized that off-pump CABG may be associated with poorer long-term survival than on-pump CABG [9]. To date, follow-up periods in the large randomized trials are still short. Because of this, there is still a need for large observational studies in the field of off-pump versus on-pump CABG. In a retrospective study of a Veterans Affairs population by Bakaeen and colleagues [9], off-pump CABG was associated with a higher 5-year and 10-year mortality (14.5% vs 13.5% and 25.2% vs 23.6%, respectively). This is in conflict with our results of similar 10-year mortality after off-pump and on-pump CABG in a study population with a mean follow-up of more than 7 years.

The strengths of our study include the large study population and the complete and accurate follow-up and survival ascertainment due to the high-quality national Swedish registers. Furthermore, the mean follow-up time of more than 7 years is relatively long for studies comparing outcomes after off-pump and on-pump CABG.

There are several important limitations of the study that need to be addressed. First, off-pump CABG was performed in only 6.6% of the patients in the study. Off-pump CABG is a technically more demanding procedure than conventional on-pump CABG and the experience of the surgical team is crucial to achieve optimal results. In previous studies, outcomes after off-pump CABG have been reported to be better at centers performing a higher number of procedures [18] and that long-term outcomes after off-pump CABG performed at low-volume centers may be inferior to on-pump CABG [9, 11]. The low number of procedures performed off-pump in our study may have negatively influenced the outcomes in this patient group and the incidence of acute kidney injury, postoperative stroke, re-exploration for bleeding, and reoperation for sternal wound complications was higher in the off-pump group compared with the on-pump group. However, long-term results after off-pump CABG was similar to on-pump CABG, indicating that off-pump CABG performed in “real world” low-volume centers may not be associated with poorer long-term survival.

As in every observational study, the findings in our study may have been influenced by selection bias. The off-pump and on-pump CABG groups were not balanced.
regarding several potentially confounding factors. Differences in baseline characteristics, such as age, between the 2 groups indicate that patients undergoing on-pump CABG in general had more comorbidities than patients undergoing off-pump CABG.

After adjustment for baseline characteristics, off-pump and on-pump CABG was associated with similar long-term survival and freedom from the composite endpoint of all-cause mortality or rehospitalization due to cardiovascular causes. To further reduce selection bias, we constructed a propensity score-matched cohort by pairing off-pump and on-pump CABG patients. The matching procedure was successful in achieving a satisfactory balance regarding baseline characteristics between the 2 treatment groups. These results reduce the probability that the findings were due to selection bias.

The number of grafted coronary arteries was fewer in the off-pump group. The national registers used did not provide information regarding extent of coronary artery disease. Fewer grafted coronary arteries may indicate less complete revascularization in the off-pump CABG group [19] and associated with poorer long-term outcomes [20]. Conversion rate from off-pump to on-pump CABG was not registered in the national registers. Poorer outcomes have been reported for patients converted from off-pump to on-pump CABG [21, 22] and a high conversion rate may therefore influence outcomes in the on-pump group negatively.

Another important variable that was not reported in the registers is ascending aortic atherosclerosis. Off-pump CABG allows for the “no touch” technique without manipulation of the aorta and bilateral internal mammary artery in situ grafting in patients with ascending aortic atherosclerosis. It is therefore possible that patients with preoperative or perioperative diagnosed aortic atherosclerosis were more likely to undergo off-pump CABG, making this an unmeasured confounder. There have been speculations about potential benefits of off-pump CABG in high-risk patients (eg, patients with aortic atherosclerosis) and recent studies reported reduced risk of stroke in high-risk patients undergoing off-pump CABG [23, 24]. No differences in cognitive outcomes have been shown in low-risk patients undergoing off-pump or on-pump CABG [25, 26].

There was a high percentage of missing data for the preoperative variables of left ventricular function, diabetes mellitus, peripheral vascular disease, estimated glomerular filtration rate, and acute perioperative kidney injury. In order to retain statistical power and reduce the selection bias that may occur when deleting observations with missing covariates, multiple imputation was used to handle missing data [27]. In addition, we performed a complete case analysis using only observations with complete data with results very similar to the results from the main analysis of the multiple imputed data.

Conclusions

Off-pump CABG was associated with similar outcomes compared with on-pump CABG in patients undergoing non-emergent primary isolated CABG in Sweden from 1998 to 2008. Off-pump CABG was performed infrequently and there was a continuous decline in the number of procedures during the study period.

References

Two observational studies [1, 2] have recently suggested whether the heart-lung machine is used or not. Off-pump coronary artery bypass graft (OPCABG) surgery has been a controversial topic for many years, with a growing number of randomized controlled trials demonstrating that early and 1-year survival are no different whether the heart-lung machine is used or not. Two observational studies [1, 2] have recently suggested that long-term survival could actually be worse after OPCABG than after conventional coronary artery bypass graft surgery (CABG) with cardiopulmonary bypass. Greater technical difficulty, fewer number of grafts with possible incomplete revascularization, and lower quality of the anastomoses in OPCABG surgery have been hypothesized as possible causes of such reduced survival.

The study by Dalén and colleagues [3] demonstrates once again that performing CABG off-pump does not improve early operative survival in a large population of unselected coronary patients, but distinguishing this study is the length of follow-up—a mean of 7.1 years with survival assessment at 10 years. Remarkably, in this extensive and meticulous retrospective observational study, on more than 50,000 consecutive patients, late survival was not at all diminished in off-pump patients, even though the percentage of OPCABG was very low and became lower as time went on (16% in the year 2000, progressing to 1% in 2008, with a variance of 3% to 11% of all isolated coronary operations in the different participating centers).

Incongruous in this study is the higher incidence of perioperative complications such as stroke, reexploration for sternal wound problems, reoperation for bleeding (each occurring twice as frequently after OPCABG), and acute renal failure recorded in the off-pump group. In fact, while some aspects of off-pump coronary surgery are still debated, randomized controlled trials have shown that OPCABG reduces bleeding, stroke, and acute kidney injury, especially in high-risk patients. This noteworthy study on a remarkably large series of patients, in a “real-world” setting, shows that OPCABG can be performed with excellent results despite infrequent performance. Further investigation of survival and freedom from major adverse events at a longer follow-up on the same series of patients would be particularly appealing.

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References