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CHRISTENSEN, Jan, et al.

Abstract

To evaluate long-term survival and need for reintervention (redo CABG or percutaneous coronary artery transluminal angioplasty, PTCA) as a result of graft materials employed at the primary coronary artery bypass grafting (CABG).


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Choice of Graft Material at Primary CABG Influences Cardiac Death and Reintervention Rates

J.T. Christenson, D. Vala, B. Faidutti, A. Kalangos
Clinic for Cardiovascular Surgery, University Hospital, Geneva, Switzerland

Abstract
Objectives: To evaluate long-term survival and need for reintervention (redo CABG or percutaneous coronary artery transluminal angioplasty, PTCA) as a result of graft materials employed at the primary coronary artery bypass grafting (CABG). Subjects and Methods: 2,327 patients who underwent primary CABG between 1980 and 1990 were followed with regard to survival and reintervention requirements for a period of 10 years. There were three groups of patients. In group 1, CABG was performed between 1980 and 1982 using veins only. Group 2 subjects had CABG done from 1983 to 1985 using veins and internal thoracic artery (ITA). Those in group 3 received two ITAs (double ITA) from 1985 to 1990. Redo CABG and PTCA were performed as needed. Results: The 10-year cumulative survival figures for the groups were 92.8% (group 1), 94.8% (group 2) and 95.4% (group 3). The difference between the groups was statistically significant (p < 0.001). Cardiac event-free survival was 74.4% (group 1), 83.5% (group 2) and 92.6% (group 3), with p < 0.0001. Myocardial infarction occurred more frequently in group 1 (4.7%) than in groups 2 or 3 (2.2 and 1.3%, respectively). The redo rates for CABG were 13.6% (group 1), 8.1% (group 2), and 1.3% (group 3). The corresponding PTCA rates for the three groups were 7.1, 3.7 and 1.6%, respectively (p < 0.0001). Conclusions: Double ITA, compared with single ITA and/or vein grafts, was the optimal graft material at the time of primary CABG because it had the lowest reintervention rate. It also did not increase postoperative morbidity.

Introduction
Numerous reports have emphasized the long-term survival superiority of double arterial conduits over veins in coronary artery bypass grafting (CABG) surgery [1–3]. Complete arterial revascularization has been strongly advocated [4, 5]. The additional benefit of double internal thoracic artery (ITA) grafts has been more difficult to demonstrate [6–8], but a recent analysis from Cleveland Clinics, Cleveland, Ohio, USA based on a large patient population has clearly demonstrated the efficacy of double ITA grafting compared to single ITA in terms of long-term benefits [9]. However, because using double ITA grafts is time-consuming and cumbersome, most cardiac
centers still tend to accept the less efficient strategy at primary CABG, namely the use of one ITA graft together with vein graft/s, which has been shown to result in higher redo rates [10]. Also, redo CABG is known to be associated with a significantly higher hospital mortality and postoperative morbidity than primary CABG [10–14]. We report our experience using different surgical strategies on graft choice at the primary CABG operation on long-term survival and redo rates in patients with vein only, artery plus vein, or double ITA grafts.

**Subjects and Methods**

**Study Population.** In a retrospective analysis, 2,327 patients who had primary myocardial revascularization (CABG) between 1980 and 1990 was done. Special emphasis was placed on survival and reintervention requirements [percutaneous transluminal coronary angioplasty (PTCA) and/or redo CABG] during a minimum follow-up period of 10 years. Group 1 was comprised of 870 patients receiving only vein grafts, group 2 included 1,032 patients who received one ITA graft + vein graft/s, and group 3 had 425 patients who received double ITA grafts (group 3) for myocardial revascularization. Preoperative patient characteristics and coronary angiographic data are given in table 1. Patients undergoing emergency operations or combined cardiac procedures were excluded since this could have affected the choice of conduit. The patients were exclusively recruited from a local and stable population corresponding to the catchment area of the university hospital, thus ensuring simple, complete and accurate follow-up.

**Definitions of Postoperative Morbidity.** Myocardial infarction was defined as the appearance of new Q waves or significant loss of R-wave forces and mean peak creatine kinase MB fractions greater than 10% of total creatine kinase. Sternal dehiscence was defined as sternal instability which required sternal refixation. Hemorrhage was defined as required re sternotomy for bleeding. Neurological events were defined as any transient or permanent neurological deficit that developed after CABG. Mediastinitis implied confirmed mediastinal infection at re sternotomy together with positive cultures.

**Statistics.** All statistical analyses were performed using a computer software program (StatView™ version 4.5, Abacus Concepts, Berkeley, Calif., USA). Student’s t test (one-sample paired test), Mann-Whitney, and Fisher’s exact test were employed to assess differences between groups for statistical significance, where appropriate. A probability level of p < 0.05 was regarded as significant. Independent predictors for reintervention during follow-up were analyzed by multivariate analysis. Nonparametric estimates of survival (death from any cause including hospital deaths) and cardiac event-free survival (myocardial infarction and reinterventions such as redo CABG and PTCA) were calculated for each group by the Kaplan and Meier method.

**Results**

During the study period, there was no change in myocardial protection or the surgical techniques – only the choice of graft material changed, as defined below. For example, the pattern of coronary disease (table 1) and the average number of distal anastomoses (2.4 ± 0.7, group 1; 2.6 ± 0.9, group 2; 2.6 ± 0.8, group 3) did not reveal any group differences.

The 10-year cumulative survival rate was significantly better when double ITA grafts were used at primary...
CABG compared to when only veins were used as bypass conduits (group 3, 406 patients at risk, versus 92.8%, group 1, 807 patients at risk; p < 0.001) and better than when one ITA and vein graft/s were used (94.8%, group 2, 981 patients at risk). Also cardiac event-free survival at 10 years was significantly better for group 3, 92.6%, compared to group 2, 83.5% and group 3, 74.4%, p < 0.0001. Multivariate analysis identified only age above 65 years (p = 0.006), triple vessel coronary artery disease (p = 0.01) and use of only vein grafts at primary operation (p < 0.0001) as independent predictors for reintervention. Age higher than 65 years (p < 0.0001), triple vessel coronary artery disease (p = 0.005), use of only vein grafts at primary operation (p < 0.0001) and left ventricular ejection fraction less than 0.40 (p < 0.0001) were identified as independent predictors of death, however, without group differences.

The average yearly reoperation rates following CABG for the three study groups are presented in figure 1. The detailed yearly reoperation rate due to severe graft stenosis or graft occlusion is shown in figure 2, and the shift in institutional policy regarding the use of ITA grafts is demonstrated in figure 3. When grouping the patients according to time periods using 1985 as breaking point (the time when double ITA grafts were frequently used at the primary CABG operation), there was a highly significant drop in reoperation rates observed (table 2). There was no increased postoperative morbidity detected in the group

Table 2. Average yearly reoperation rate following primary CABG in patients operated between 1980 and 1990 and followed for at least 10 years, comparing two time periods (mean ± SD)

<table>
<thead>
<tr>
<th>Time period</th>
<th>Average reoperation rate</th>
<th>Range, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980–1985</td>
<td>12.0 ± 3.6%</td>
<td>8.2–17.0</td>
</tr>
<tr>
<td>1986–1990</td>
<td>2.2 ± 0.9%</td>
<td>1.1–3.4</td>
</tr>
</tbody>
</table>

p value <0.0001

Fig. 1. Average yearly reoperation rates after myocardial revascularization with vein grafts only (group 1), one ITA + vein graft/s (group 2) and double ITA grafts (group 3).

Fig. 2. Yearly reoperation rates for patients undergoing primary CABG surgery between 1980 and 1990.

Fig. 3. The use of autologous saphenous vein and internal thoracic artery (ITA) as bypass conduit in primary CABG operations between 1980 and 1999.

Impact of Conduit on the Outcome of Myocardial Revascularization
Table 3. Postoperative morbidity comparing patients who received double ITA, single ITA + vein/s, and vein graft only, undergoing primary CABG between 1980 and 1990

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group 1 vein grafts only (n = 870)</th>
<th>Group 2 single ITA + vein/s (n = 1,032)</th>
<th>Group 3 double ITA grafts (n = 425)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myocardial infarction</td>
<td>4.7% p &lt; 0.0001</td>
<td>2.1% p &lt; 0.0001</td>
<td>1.2%</td>
</tr>
<tr>
<td>Refixation of sternum due to sternal dishiscence</td>
<td>1.0%</td>
<td>0.7%</td>
<td>0.9%</td>
</tr>
<tr>
<td>Resternotomy for bleeding</td>
<td>0.6%</td>
<td>0.7%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Mediastinitis</td>
<td>0.0%</td>
<td>0.2%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Bleeding requiring blood transfusion</td>
<td>0.6%</td>
<td>0.7%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Prolonged ventilatory support &gt;24 h</td>
<td>25.3%</td>
<td>26.7%</td>
<td>24.7%</td>
</tr>
<tr>
<td>Intensive care unit stay &gt;48 h</td>
<td>18.1%</td>
<td>16.2%</td>
<td>15.5%</td>
</tr>
</tbody>
</table>

χ² test was used. Statistically significant group differences are shown by p values. All other group differences were statistically not significant (p > 0.05).

Fig. 4. Incidence of reinterventions (redo CABG or PTCA) 10 years following myocardial revascularization with vein grafts only (group 1), one ITA + vein graft/s (group 2) and double ITA grafts (group 3).

Discussion

Changing Surgical Strategies on Choice of Conduits at Primary CABG

Prior to 1985, autologous saphenous vein grafts were predominantly used as bypass conduits at our institution, comprising 99% of all grafts used in 1980. The utilization of a single ITA graft as conduit was first introduced in 1980, and was increasingly used alone or together with vein grafts over the years to follow. However, after observing a steady increase in the yearly need for reopera-
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In contrast to previous reports [9, 18], we did not demonstrate an increased postoperative morbidity when double ITA grafts were used compared to single ITA use, and hospital mortality did not show group differences. In patients who present with two patent ITA grafts but a symptomatic progression of their native vessel atherosclerotic disease, PTCA can be performed with maximal security. Double ITA grafts can also be employed when surgical myocardial revascularization is performed in extremely high-risk coronary patients, provided preoperative intra-aortic counterpulsation therapy is given to diminish myocardial ischemia and that the patient is stabilized prior to aortic cross-clamping, which will allow ample time to prepare the two ITAs [23]. Even if double ITA grafting is more demanding and time-consuming, utilization of double ITA grafts ought to become the gold standard strategy at the primary CABG operation, since it has been demonstrated both in this study and others [9, 15, 16] that double ITA grafting has superior long-term results.

Conclusion

Double ITA grafts at the time of primary CABG have been shown to be superior to single ITA and/or vein graft/s. Double ITA grafts reduce both the risk of cardiac death and need for subsequent reintervention, contributing to better prospects for long-term survival.
References


