The influence of ascending aortic atherosclerosis on the long-term survival after CABG

Thomas Schachner*, Anne Zimmer, Georg Nagele, Herbert Hangler, Günther Laufer, Johannes Bonatti

Department of Cardiac Surgery, Innsbruck Medical University, Innsbruck 6020, Austria

Received 26 April 2005; received in revised form 2 July 2005; accepted 4 July 2005; Available online 26 August 2005

Abstract

Objective: Ascending aortic atherosclerosis is a risk factor for perioperative morbidity and mortality in coronary surgery. It was the aim of our study to determine the role of atherosclerosis of the ascending aorta and other factors for the survival rate during long-term follow-up after CABG.

Methods: From 500 out of 580 CABG patients (aged 67 (33–85) years, 77% male), who underwent intraoperative epiaortic ultrasound for assessment of ascending aortic wall thickness, a complete follow-up regarding long-term survival was achieved. The median follow-up time was 55 (1–78) months. Results: 53/500 (11%) patients died within the follow-up period, and the cumulative survival rate was 95, 90, and 84% after 1, 3, and 5 years, respectively (including hospital deaths). A significantly lower long-term survival was present in patients with: an age of 70 years or more (P < 0.001), COPD (P = 0.005), preoperative elevated serum creatinine of > 1.2 mg/dl (P = 0.007), preoperative LVEF < 40% (P = 0.033), ascending aortic wall thickness of 4 mm or more (P < 0.001), carotid artery disease (P < 0.001), peripheral vascular disease (P < 0.001), and acute operation (P = 0.009). Multivariate analysis revealed carotid artery disease, LVEF < 40%, peripheral vascular disease, and advanced age to be independent risk factors.

Conclusion: Patients with ascending aortic atherosclerosis are at risk for a decreased long-term survival after CABG. Besides, preoperative elevated serum creatinine, COPD, carotid artery disease, LVEF < 40%, peripheral vascular disease, and advanced age are risk factors for a decreased long-term survival after CABG.

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Keywords: Atherosclerosis; Coronary; Epiaortic ultrasound; Ascending aorta; CABG; survival

1. Introduction

The long-term survival rates after CABG are in the 90% range at 5 years postoperatively. Different risk factors for a decreased long-term survival have been described in literature, some of which controversially.

Ascending aortic atherosclerosis is a risk factor for perioperative morbidity (esp. strokes) and mortality following cardiac surgery. However, little is known about its role for long-term survival. Epiaortic ultrasound is the gold standard to quantify ascending aortic atherosclerosis, and it is a quickly and easily performed diagnostic measurement for the cardiac surgeon. Ascending aortic atherosclerosis is an indicator for ‘advanced biology’ and it is associated with other pathologies such as descending aortic atherosclerosis and peripheral vascular disease in CABG patients [1–4].

We aimed to determine the influence of ascending aortic atherosclerosis and other factors on the long-term survival after CABG.

2. Patients and methods

Between 1998 and 2004, 580 patients underwent epiaortic ultrasound during CABG operations. Intraoperative ultrasound measurements were entered prospectively into a distinct protocol. The follow-up data of 500 patients, regarding their survival status could be obtained by telephone interview with relatives or the referring physician. The patient characteristics are shown in Table 1.

Ascending aortic atherosclerosis was quantified at the time of operation by epiaortic ultrasound in all patients. After sternotomy and opening of the pericardium, the maximum ascending aortic wall thickness (MAAWT) was measured using a 7.5 MHz linear ultrasound probe (with a film of gel applied on its tip and wrapped with a sterile plastic bag) as previously described [4].

Left ventricular ejection fraction (LVEF) was determined by preoperative cardiac catheterisation or echocardiography by an experienced cardiologist.

Carotid artery disease was defined as the presence of carotid artery stenosis of 50% or more, or carotid artery occlusion, or status post carotid endarterectomy. All patients underwent sonography of the carotid arteries preoperatively.

* Corresponding author. Tel.: +43 512 504 80820; fax: +43 512 504 22528. E-mail address: thomas.schachner@uibk.ac.at (T. Schachner).
Chronic obstructive pulmonary disease (COPD) was defined by long-term use of bronchodilators or steroids for lung disease and by significant findings in preoperative spirometry, which was performed in all patients of this series.

Peripheral vascular disease was defined as presence of intermittent claudication, or previous or planned intervention on the abdominal aorta or limb arteries.

Unstable angina was defined according to the STS database as: Rest angina, New onset (<2 months) of Canadian Cardiovascular Society Class (CCSC) III, recent (<2 months) acceleration in pattern and increase of one CCSC class to at least CCSC III, Non Q wave myocardial infarction, post-infarction angina (>24 h).

Hypertension was diagnosed if a blood pressure of >140 mmHg systolic or >90 mmHg diastolic was documented, or if the patient was currently on antihypertensive medication, or if the patient had a history of hypertension.

### 3. Statistical analysis

Statistical analysis was carried out using the SPSS™ 10.0 software.

Continuous variables are given as median and minimum-maximum. Categorial variables are given as percentages. For calculation of survival rates Kaplan-Meier curves and life-table (Table 2) were used. Factors associated with long-term survival were calculated using the Log Rank test. A multivariate, stepwise Cox regression analysis was conducted to determine independent predictors of long-term survival after CABG. The criterion for a variable entry into multivariate analysis was a univariate probability level of $P < 0.05$. Results were considered statistically significant at $P$ values of less than 0.05.

### 4. Results

During a follow-up time of 55 (1–78) months 53 deaths occurred (including hospital deaths). The number of patients at risk was 413, 318, and 86 at 1, 3, and 5 years, respectively.

The overall survival rates were 95, 90, and 87% after 1, 3, and 5 years, respectively. Eleven deaths occurred perioperatively. The causes of hospital mortality were low-cardiac output syndrome in five, multisystem organ failure in four, mesenteric ischemia in one, and sepsis in one patient. The other causes of death were cardiac death in 13 cases, stroke in six cases, tumor in five cases, others (including renal failure, during later noncardiac surgery, peritonitis) in eight cases, and unknown in 10 cases.

Table 2 shows 1-, 3-, and 5-year survival rates depending on different risk factors.

<table>
<thead>
<tr>
<th>Factor (number of patients at risk)</th>
<th>1 year (n = 413)</th>
<th>3 years (n = 318)</th>
<th>5 years (n = 86)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients</td>
<td>95%</td>
<td>90%</td>
<td>84%</td>
</tr>
<tr>
<td>Age &gt; 70 years at operation</td>
<td>91%</td>
<td>82%</td>
<td>72%</td>
</tr>
<tr>
<td>Age &lt; 70 years at operation</td>
<td>96%</td>
<td>94%</td>
<td>89%</td>
</tr>
<tr>
<td>COPD</td>
<td>90%</td>
<td>81%</td>
<td>56%</td>
</tr>
<tr>
<td>No COPD</td>
<td>95%</td>
<td>91%</td>
<td>86%</td>
</tr>
<tr>
<td>Preoperative serum creatinine &gt; 1.2 mg/dl</td>
<td>88%</td>
<td>84%</td>
<td>80%</td>
</tr>
<tr>
<td>Preoperative serum creatinine ≤ 1.2 mg/dl</td>
<td>97%</td>
<td>92%</td>
<td>85%</td>
</tr>
<tr>
<td>Preoperative LVEF &lt; 40%</td>
<td>89%</td>
<td>82%</td>
<td>77%</td>
</tr>
<tr>
<td>Preoperative LVEF ≥ 40%</td>
<td>95%</td>
<td>91%</td>
<td>85%</td>
</tr>
<tr>
<td>Ascending aortic wall 4 mm or more</td>
<td>88%</td>
<td>79%</td>
<td>70%</td>
</tr>
<tr>
<td>Ascending aortic wall &lt; 4 mm</td>
<td>96%</td>
<td>93%</td>
<td>87%</td>
</tr>
<tr>
<td>Carotid artery disease</td>
<td>89%</td>
<td>79%</td>
<td>62%</td>
</tr>
<tr>
<td>No carotid artery disease</td>
<td>96%</td>
<td>93%</td>
<td>91%</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>84%</td>
<td>76%</td>
<td>64%</td>
</tr>
<tr>
<td>No peripheral vascular disease</td>
<td>97%</td>
<td>93%</td>
<td>88%</td>
</tr>
<tr>
<td>Acute operation</td>
<td>89%</td>
<td>82%</td>
<td>34%</td>
</tr>
<tr>
<td>No acute operation</td>
<td>95%</td>
<td>90%</td>
<td>87%</td>
</tr>
</tbody>
</table>

The overall survival rates were 95, 90, and 87% after 1, 3, and 5 years, respectively. Eleven deaths occurred perioperatively. The causes of hospital mortality were low-cardiac output syndrome in five, multisystem organ failure in four, mesenteric ischemia in one, and sepsis in one patient. The other causes of death were cardiac death in 13 cases, stroke in six cases, tumor in five cases, others (including renal failure, during later noncardiac surgery, peritonitis) in eight cases, and unknown in 10 cases.

Table 2 shows 1-, 3-, and 5-year survival rates depending on different risk factors.

The following risk factors were significantly associated with a lower long-term survival: age of 70 years or more at the time of operation ($P < 0.001$), chronic obstructive pulmonary disease ($P = 0.005$, Fig. 1), preoperative elevated serum creatinine of $>1.2$ mg/dl ($P = 0.0068$), preoperative LVEF < 40% ($P = 0.033$, Fig. 2), maximum ascending aortic wall thickness of 4 mm or more ($P = 0.001$, Fig. 3), carotid...
artery disease \( (P < 0.001, \text{Fig. 4}) \), peripheral vascular disease \( (P < 0.001, \text{Fig. 5}) \), and acute operation \( (P = 0.009) \).

In the multivariate Cox regression model, carotid artery disease \( (P = 0.013) \), left ventricular ejection fraction <50\% \( (P = 0.009) \), peripheral vascular disease \( (P = 0.009) \), and age >70 years \( (P < 0.001) \) were found to be independently associated with an increased long-term mortality after CABG (Table 3).

Gender, previous cardiac surgery, diabetes mellitus, hypertension, and preoperative unstable angina were not significantly associated with long-term survival.

5. Discussion

Several patient-related variables are discussed in the literature to influence long-term survival of patients undergoing CABG. Some of these variables are obtained easily (e.g., age, serum creatinine) and others require additional examinations such as spirometry, echocardiography, and epiaortic ultrasound. Ascending aortic atherosclerosis is increasingly gaining interest. On the one hand, changes of the operative technique, such as single cross clamp, use of Y-grafts, or OPCAB, may be required if a 'risky' ascending aorta is present. On the other hand, a population at risk of strokes or death in the long-term may be found by using epiaortic ultrasound.

In our series, age was the most powerful predictor of survival rates. This is not surprising and it is well in accordance with other authors' findings [1,5–7].

Patients with COPD had a decreased long-term survival in our series. This is in agreement with Medalion and co-workers who found COPD as a risk factor for decreased survival after CABG [8]. But this group also found out that
patients with COPD improved in quality of life after CABG operation.

Chronic renal insufficiency with a serum creatinine >1.5 mg/dl and serum creatinine >2 mg/dl has been shown to decrease long-term survival after CABG [6,9]. In our series we found an increase of serum creatinine even above 1.2 mg/dl as a risk factor for late mortality after CABG.

Left ventricular dysfunction is known to decrease long-term survival. Appoo et al. as well as Sergeant et al. have demonstrated an increased early and late mortality in CABG patients with reduced LVEF [1,10]. We found an approximately 10% decreased long-term survival in patients with a LVEF <40% compared with patients with a LVEF >40%. Nevertheless, it has been shown that patients with left ventricular dysfunction and coronary artery disease benefit from CABG surgery compared with medical treatment alone.

Since the incidence of carotid artery disease is reported in up to one-fifth of patients undergoing CABG this is an important comorbidity. We and others have shown an increased long-term stroke rate in patients with carotid artery stenosis [11,12]. Tunio and co-workers found doubled perioperative mortality after CABG in patients with carotid artery disease [13]. In our series carotid artery disease was associated with an one third reduction of the 5-year survival rate compared with patients without carotid artery disease.

In our series peripheral vascular disease was quite frequent affecting almost every fifth patient. Furthermore these patients were at a higher risk of late mortality after CABG compared with patients without peripheral vascular disease. These findings are in agreement with Calafiore et al., who found peripheral vascular disease as a risk factor of long-term mortality after CABG [6].

Urgent CABG is a risk factor of early mortality after CABG [6,14,15]. However, the role of urgent CABG for long-term survival is controversial. We found out that acute operation is associated with a decreased long-term survival. On the other hand Calafiore et al. found urgent operations associated with early, but not with late mortality [6].

Ascending aortic atherosclerosis is associated with an increased early and long-term morbidity, especially cerebrovascular accidents [2,3,11]. Amanullah et al. could demonstrate an increased 1-year mortality in patients with complex plaques (4 mm thickness or more, as determined by TEE) of the ascending aorta or aortic arch [16]. In agreement with this finding we saw ascending aortic atherosclerosis associated with a decreased long-term survival.

Diabetes mellitus is discussed controversially with regard to long-term survival after CABG. Leavitt et al. found a decreased long-term survival in patients with diabetes whereas Calafiore et al. did not [6,17]. However, in our series we did not find patients with diabetes at higher risk of death after CABG in the long-term.

Gender is another risk factor that is controversially discussed in literature. Weintraub et al. found female gender as a risk factor for late mortality after CABG [5]. Nakayama et al., as well as we did in this study, noticed no association between gender and long-term survival after CABG [9].

In summary we found, besides other factors, a clear influence of ascending atherosclerosis on the long-term survival after CABG. Thus by using epiaortic ultrasound to quantify ascending aortic atherosclerosis a population at risk for long-term lethal events can be detected. A closer medical follow-up of these patients is maybe beneficial.

### References


