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Coronary artery bypass surgery in young adults: excellent perioperative results and long-term survival

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Abstract

OBJECTIVES: To analyse perioperative results, long-term survival and freedom from complications after coronary artery bypass grafting (CABG) in young adults.

METHODS: A total of 163 patients, 40 years old or younger, had isolated CABG from January 1989 to December 2010. Pre- and perioperative demographic and clinical data were retrieved from a prospectively organised database. Follow-up data were obtained by letter or telephone interviews. The mean age of the patients was 37.6 ± 2.9 years and 146 were men (90%). Fifty-three patients (32.5%) had angina class III/IV; 106 (65.0%), previous myocardial infarction; and 23 (14.1%), impaired left ventricular function (ejection fraction <40%). Indication for surgery was 3-vessel disease in 101 cases (62.0%), 2-vessel disease in 30 (18.4%) and single-vessel disease in 32 (19.6%). The left main stem was affected in 16 patients (9.8%). The mean EuroSCORE II was 0.92 ± 0.71. A total of 417 grafts were constructed (mean 2.6 grafts/patient), 247 of which (59.2%) were arterial.

RESULTS: There were no in-hospital deaths. The mean hospital stay was 7.1 ± 4.0 days. Four patients (2.5%) were lost to follow-up, which extended from 3 to 25 years (mean 15.1 ± 5.5 years). There were 22 late deaths, 72.7% of cardiac or unknown origin. The 5-, 10- and 20-year survival rates were 98.7 ± 10.9, 95.2 ± 1.8 and 79.4 ± 4.4%, respectively. Twenty-six patients (18.1%) had non-fatal cardiac adverse complications (myocardial infarct, percutaneous re-revascularization or class III/IV angina), for 5-, 10- and 20-year freedom from complications of 97.9 ± 1.2, 91.9 ± 2.5 and 65.7 ± 7.1%, respectively. Twenty-two patients (17.5%) needed re-revascularization, for 5-, 10- and 20-year freedom from re-revascularization of 97.6 ± 1.4, 91.9 ± 2.6 and 69.5 ± 6.7%, respectively.

CONCLUSIONS: Despite the aggressive nature of coronary artery disease in young patients, perioperative death and morbidity rates are low, with good long-term survival and low rates of re-revascularization.

Keywords: CABG • Young adults • Long-term follow-up • Non-fatal cardiac complications • Percutaneous revascularization

INTRODUCTION

Coronary artery disease (CAD) is one of the most prevalent cardiac diseases in industrialized countries and is associated with high rates of mortality and morbidity [1]. It mainly affects older adults, the reported incidence among young adults being only 3–6% [2]. Since Yater described the presence of CAD in autopsy reports of young soldiers in 1948, the data about outcomes in young people are relatively scarce [3]. Although coronary bypass grafting (CABG) is one of the most extensively studied surgical techniques for the treatment of the disease, only a few studies have been performed to characterize and compare the risk factors and outcomes of this young group with those of older patients [3].

Our goal was to analyse the perioperative results and long-term survival after CABG in a young adult population.

PATIENTS AND METHODS

Preoperative demographic, clinical and perioperative in-hospital outcome data were retrieved from a prospectively organized computerized database, which allowed later calculation of the EuroSCORE II of each patient enrolled and a comparison between the young and the older groups. All patients had preoperative coronary angiographic examinations and, when justified, myocardial viability studies. Follow-up data were obtained from hospital records and by letter or telephone interview with patients or members of their families. Registries from the national electronic health care database provided information about re-revascularization procedures, major morbidities and date and cause of death. Because of the sheer size of the global population, and because it was not the main objective of this work, a follow-up survey was not conducted in the older group.

Table 1: Demographic data: comparison between the young and the older age groups

	≤40 years	>40 years	*P*-value
N (%)	163 (1.9)	8462 (98.1)	
Age, years, mean ± SD	37.6 ± 2.9 (range 23–40)	61.8 ± 9.0 (range 41–86)	<0.001
Male sex, *n* (%)	146 (90)	7410 (87.6)	0.46
Body mass index, kg/m^2, mean ± SD	26.0 ± 2.9	26.1 ± 2.2	0.95
Diabetes mellitus, *n* (%)	20 (12.3)	2088 (24.8)	<0.001
Hypertension, *n* (%)	64 (39.3)	5153 (61.3)	<0.001
Active smoker, *n* (%)	131 (81.4)	4175 (49,3)	<0.001
Creatinine clearance, ml/min, mean ± SD	117.8 ± 27.2	78.9 ± 23.6	<0.001
Peripheral vascular disease, *n* (%)	3 (1.8)	755 (9.8)	0.001
Cerebrovascular disease, *n* (%)	0	473 (6.6)	<0.001
Family history, *n* (%)	61 (37.4)	1566 (18.7)	<0.001
Angina (CCS III–IV/IV), *n* (%)	53 (32.5)	3065 (36.2)	0.05
Unstable angina, *n* (%)	13 (8.0)	572 (7.4)	0.47
CABG within 30 days of myocardial infarction, *n* (%)	21 (12.9)	743 (8.8)	0.18
LV dysfunction (EF < 40%), *n* (%)	23 (14.1)	1085 (12.8)	0.51
Chronic lung disease, *n* (%)	1 (0.6)	240 (3.1)	0.13

CABG: coronary artery bypass grafting; CCS: Canadian Cardiovascular Society; EF: ejection fraction; LV: left ventricular

The study population cohort comprised 163 patients 40 years old or less who had a CABG operation from January 1989 through December 2010, corresponding to 1.9% of the 8,625 consecutive patients who had isolated CABG in our centre during the same period. These patients, 146 (90%) men, had a mean age of 37.6 ± 2.9 years (range 23–40 years), and 108 (66%) were operated on before 2001. Fifty-three patients (32.5%) presented with Canadian Cardiovascular Society class III/IV angina; 106 (65.0%) had previously suffered a myocardial infarction (12.9% underwent CABG within 30 days of a myocardial infarction) and 23 (14.1%) had impaired left ventricular function (ejection fraction <40%). The demographic characterization of this young CABG group and the comparison with the older age group, for reference, are presented in Table 1.

Smoking was the most prevalent risk factor for CAD and was observed in 81.4% of the cases, followed by hypertension (39.3%) and family history (37.4%). The indication for surgery was 3-vessel disease in 101 patients (62%), 2-vessel disease in 30 (18.4%) and single-vessel disease in 32 (19.6%). The main stem of the left coronary artery was affected in 16 cases (9.8%). The calculated mean EuroSCORE II was 0.92 ± 0.71 (range 0.5–5.92). A total of 417 grafts were constructed, with a mean of 2.6 grafts per patient; 247 (59.2%) grafts were arterial. The type and number of grafts per patient are summarized in Table 2. A total of 100% of patients had at least one arterial graft (the left internal thoracic artery [ITA]). In 59% of the patients who had multivessel revascularization, both left and right ITA grafts were used.

Surgery was performed under extracorporeal circulation and beating heart/ventricular fibrillation in 91.4% of the cases, without clamping of the aorta, as previously described [4], with a mean extracorporeal circulation time of 55.2 ± 27.7 min. The remaining 14 patients (8.6%) had 'off-pump' surgery, mostly for isolated LAD lesions. Ninety-two percent of the operations were elective, 5% were urgent and 1.8% were emergent. It is our routine approach to use a pedicled left ITA graft for the left anterior descending artery and a free right ITA graft for the circumflex artery or its branches, if the anatomical configuration permits, and a vein graft for the right coronary artery or its branches. No radial grafts were used in these patients.

Table 2: Types and numbers of grafts

Graft type	*N*	%	Mean/ patient ± SD
Total	417	100	2.6 ± 1.0
Arterial	247	59.2	1.5 ± 0.57
LITA	82	50.3	
LITA + RITA	75	46.0	
LITA + sequential RITA	6	3.7	

LITA: left internal thoracic artery; RITA: right internal thoracic artery.

Although the medical treatment of these patients before and after surgery differed over time, the main principles of medical treatment and the surgical technique remained basically unaltered, allowing for patients to be included in the study over such a long period.

During their hospital stay, patients were instructed about cardiovascular risk factors and how to control them and encouraged to adopt healthier habits (e.g. avoid sedentary lifestyle, optimize blood pressure, control diabetes, lose weight and stop smoking).

Statistical analysis

In accordance with the statistical and data reporting guidelines of the European Journal of Cardio-Thoracic Surgery [5], continuous variables are presented as the mean ± the standard deviation (SD). The Student *t*-test was used to compare means. Categorical variables are expressed as frequencies and percentages, and comparisons were made using the Pearson's χ^2 test or the Fisher exact test if the expected cell frequencies were less than 5. Overall survival and freedom from complications were analysed by the Kaplan–Meier method. Curves were compared using a log-rank test. A multivariable analysis to identify the risk factors for late mortality was performed using Cox regression models (step-wise analysis). A *P*-value of <0.05 determined statistical

Table 3: Late follow-up data of complications and cardiovascular risk factors after CABG for the ≤40-year age group*

	N/available data (%)
De novo myocardial infarct	11/125 (8.8)
Cerebrovascular accident	4/125 (3.2)
Percutaneous revascularization	22/126 (17.5)
Heart transplant	1/125 (0.8)
Angina CCS III–IV/IV	5/109 (4.6)
Body mass index, kg/m^2 (mean ± SD)	27.0 ± 5.5/103
Diabetes mellitus	40/121 (33.1)
Active smoker	23/117 (19.7)

CCS: Canadian Cardiovascular Society.

*CCS: Canadian Cardiovascular Society. For each of the categorical variables, the number of patients (N), the available data (N) and the corresponding percentages are specified. For continuous variables, mean ± SD and the available data are specified.

significance. Data were analysed by the IBM SPSS Statistics for Macintosh, Version 22.0 (IBM Corp., Armonk, NY).

RESULTS

There were no in-hospital deaths, but 6 patients (3.6%) had relevant perioperative morbidity: 2 (1.2%) had an acute myocardial infarct, 3 (1.8%) had a cerebrovascular accident or transient ischaemic attack and 1 had a sternal infection (0.6%) with the need for surgical debridement and sternal refixation. After hospital discharge, 1 patient, who had been under haemodialysis preoperatively, died of pneumonia, for a 30-day mortality rate of 0.6%. During the same period, the mortality rate for isolated CABG in the older group was 1.0%, 2.7% of the patients had an acute myocardial infarct and 2.6% had a cerebrovascular accident (including a transient ischaemic attack) perioperatively. Mean hospital stay was 7.1 ± 4.0 days for the younger and 7.8 ± 6.3 days for the older group ($P = 0.17$).

In the younger group, the follow-up (ending December 2014) extended from 3 to 25 years for a cumulative 2406 patient-years and a mean of 15.1 ± 5.5 years per patient. Four patients (2.5%) were lost to follow-up. The late complications and prevalence of risk factors are described in Table 3.

There were 22 late deaths (13.8%), 72.7% of cardiac or unknown origin. The 5-, 10- and 20-year actuarial survival rates were 98.7 ± 10.9, 95.2 ± 1.8 and 79.4 ± 4.4%, respectively (Fig. 1). Freedom from death of cardiac or unknown causes for the same time intervals was 99.4 ± 0.6, 97.2 ± 1.4 and 85.4 ± 3.6% (Fig. 2). A logistic regression analysis was performed, and the following independent risk factors for long-term mortality were identified: cardiopulmonary bypass time (hazard ratio [HR]: 1.04; 95% confidence interval (95% CI): 1.01–1.06; $P = 0.006$) and use of only one ITA in multivessel disease (HR: 2.82; 95% CI: 1.04–7.65; $P = 0.042$).

Twenty-six patients (18.1%) suffered at least one of the following non-fatal adverse cardiac complications: myocardial infarction, Canadian Cardiovascular Society class III-IV/IV angina or need of percutaneous revascularization. Five-, 10- and 20-year freedom from non-fatal cardiac complications was 97.9 ± 1.2, 91.9 ± 2.5 and 65.7 ± 7.1%, respectively (Fig. 3). No patient required repeat surgical revascularization, but percutaneous intervention was necessary in 22 patients (17.5%), with a 5-, 10- and 20-year freedom from percutaneous coronary re-revascularization of 97.6 ± 1.4, 91.9 ± 2.6 and 69.5 ± 6.7% (Fig. 4). One patient (0.8%) with dilated ischaemic cardiomyopathy received a heart transplant.

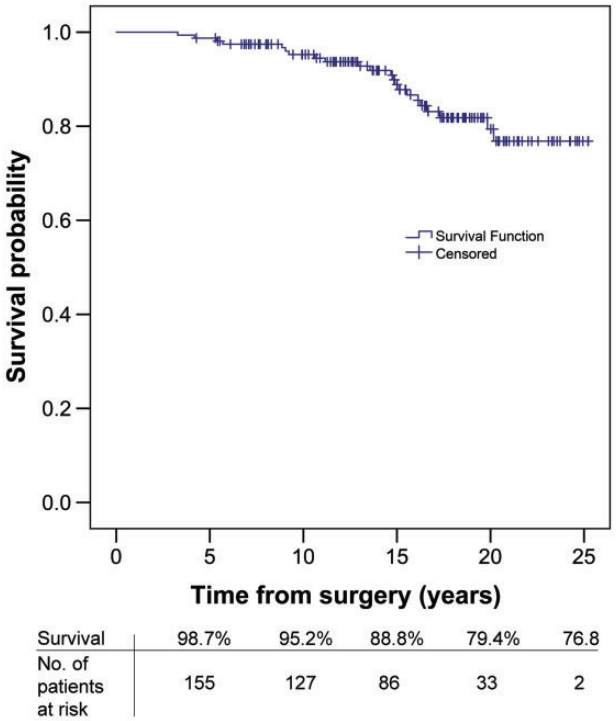


Figure 1: Survival curve after coronary artery bypass grafting.

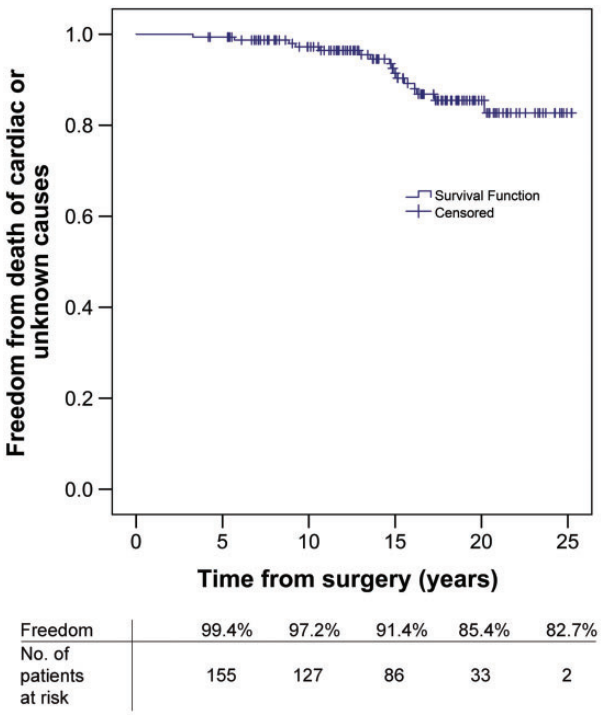
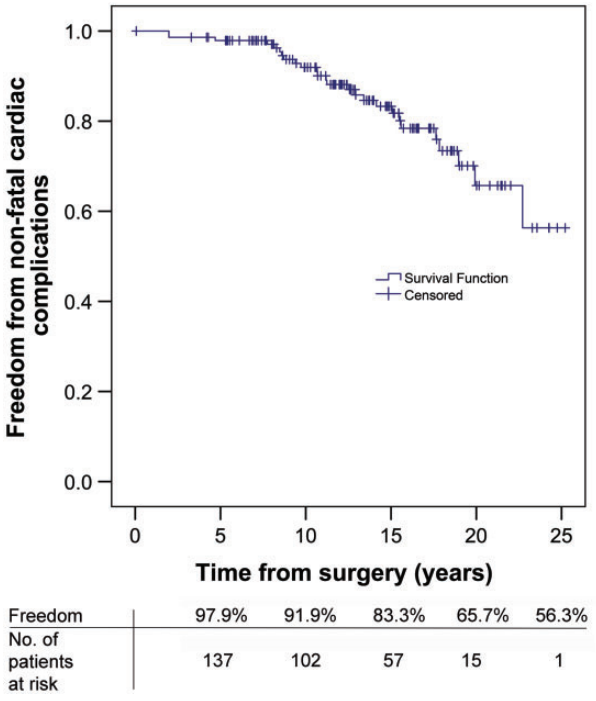
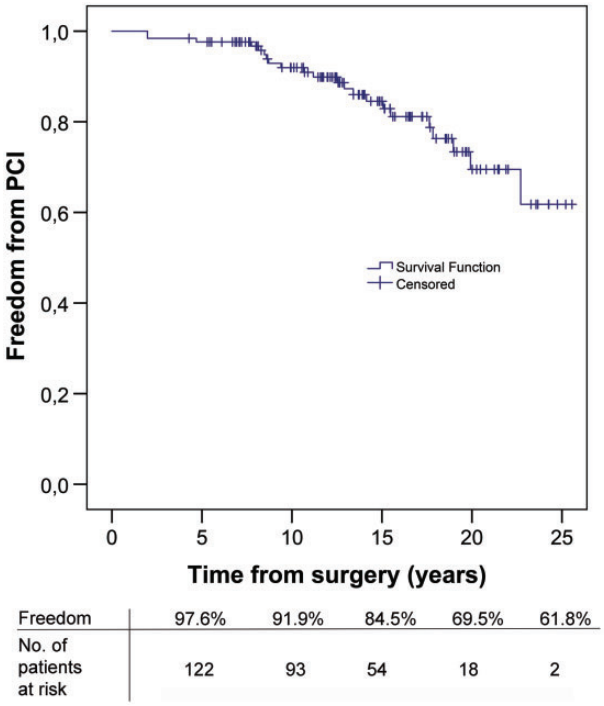


Figure 2: Freedom from death of cardiac or unknown causes after coronary artery bypass grafting.



Freedom	97.9%	91.9%	83.3%	65.7%	56.3%
No. of patients at risk	137	102	57	15	1

Figure 3: Freedom from non-fatal cardiac complications.



Freedom	97.6%	91.9%	84.5%	69.5%	61.8%
No. of patients at risk	122	93	54	18	2

Figure 4: Freedom from percutaneous coronary re-revascularization.

Information about current therapy at follow-up was available for only two-thirds of the patients, but it was possible to determine that 88% were taking aspirin and/or other antiplatelet therapy; 62%, beta-blockers; 58%, ACE inhibitors or angiotensin receptor antagonists; and only 13%, calcium channel blockers.

DISCUSSION

Our young population group comprised only 1.9% of the whole population who had isolated CABG during the same period. Although the incidence of CAD among young adults has been reported to be from 3% to 6% [2], it is possible that young patients are currently preferentially referred for percutaneous rather than surgical revascularization, which may explain the small number of cases in recent years. On the other hand, the diagnosis is not always clear in this age group; there are usually fewer symptoms and patients present with some degree of left ventricular dysfunction.

Smoking was the most prevalent cardiovascular risk factor in this population, present in more than 80% of the patients, followed by hypertension and family history. The much higher rate of smoking among our young patients than among the older group must be one important reason for such early manifestation of CAD. Smoking has also been identified in other studies as the most relevant risk factor for CAD in young people, with similar percentages [6-9]. A family history is also often identified, with a prevalence varying between 14% and 69% [2,8,9], and was present in our young patients at a rate double that among older patients. According to some reports, this factor may be associated with metabolic, coagulation or other genetic factors that would justify the high prevalence among young compared to older patients [8].

Otherwise, this young population has fewer risk factors for surgery than the older patients, which is reflected in the low EuroSCORE II value in the current series. Diabetes, hypertension, renal dysfunction, peripheral vascular disease and cerebrovascular disease were significantly less prevalent in the younger patients than in the older group operated on during the same period in our centre. The incidence of chronic lung disease was also higher in the older group. Hence, as recognized by other studies, the operative mortality was lower, tending to approach zero [2,8,10]. In our series, there was no in-hospital mortality and the incidence of perioperative morbidity was low. The hospital stay was also shorter. Hence, this surgery in young patients is safe and efficient [2,3,7].

In this study, all patients had at least one arterial graft and almost two-thirds of all grafts constructed were arterial: single left ITA in 50.3% and double ITA in 46% of the cases. Our policy of using arterial grafts for the left anterior descending and circumflex arteries and their branches reflects the modern trend, contributing to better long-term results [6,11]. In this population, a double ITA was not used only when the circumflex system did not require revascularization or the anatomical characteristics were unsuitable. Yet, use of only one ITA in multivessel disease was identified as an independent risk factor for long-term mortality. In the meantime, we remain faithful to the preferential use of vein grafts to the right coronary territory, awaiting more evidence in this area.

The follow-up extended for 25 years, with a mean of 15 years per patient. The 5-year survival of 98.7% was comparable to, if not better than, that reported by others [7]. And at longer follow-up the survivals follow the same tendency; for example, in the study by Rohrer-Gubler *et al.*, the 15-year survival rate of a young group was 72%, whereas it was 89% in our series, and the 20-year survival was almost 80% [12]. In fact, our 20-year survival rate appears to be one of the longest and best ever reported for this type of patient and may serve for future comparisons, even with other revascularization techniques.

Almost three-quarters of our late deaths were considered to be due to cardiac causes. Because many patients were not in the direct influence area of our hospital, it was difficult to obtain the cause of death in many circumstances. Thus, and in accordance

with accepted guidelines, the cause of death was presumed to be cardiac in origin, which may have contributed to an overestimate of the rates and a reduction in the freedom rates. Yet, the long-term freedom from non-fatal cardiac complication rate was encouraging. For example, our freedom from cardiac complications of 65.7% at 20 years compares well with that reported in the study by Hurlè and colleagues of 43.9% at 16 years [3].

Only 17.5% of our patients needed a re-revascularization procedure, all of which were done by the percutaneous approach. Freedom from re-revascularization 20 years after surgery was almost 70%. Again, this compares satisfactorily with the results reported by others [3,12]. In addition, it compares favourably with the results of percutaneous coronary intervention with stent implantation. For example, in the study by Ellis *et al.*, repeat revascularization was required in almost half of the patients by 5 years [13]; in the recent study by Meliga and colleagues, the need for a new revascularization was 12.6% after only 2 years [14].

Finally, we make a special effort to provide the patients and their families with information about cardiovascular risk factors and ways to control them, especially during their hospital stay, when they are more receptive and motivated. We believe these educational efforts contribute to their change of habits and improved adherence to therapeutic plans, which may have contributed to a decrease in the rate of disease progression and the good results of our study.

Limitations of the study

We recognize some limitations in this study, which may affect its conclusions. Although our experience was from a single centre with a highly experienced staff and a specific surgical technique (which we recommend), it may be generalizable to other cardiac surgical centres. Also, the number of patients enrolled was relatively small for the long interval and did not allow an adequate analysis of the evolution of clinical and technical strategies over the decades. Although we have one of the longest follow-up periods reported, we were not able to collect all of the information about therapeutic strategies or morbidities from all of the patients. We also acknowledge the natural limitations of this being a retrospective study.

CONCLUSIONS

This study shows that perioperative mortality and morbidity are low in young patients undergoing coronary artery bypass surgery and that the long-term survival is good, with minimal need for re-revascularization.

Conflict of interest: none declared.

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