

## Changing Lifestyle Habits as Secondary Prophylaxis after Coronary Artery Bypass Grafting

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### ABSTRACT

**Background:** Many studies have investigated the effect on mortality and morbidity of modified risk factors after coronary artery bypass grafting (CABG). We performed a retrospective survey to evaluate changing lifestyle habits after CABG during 1990-2003, focusing on the correlation between lifestyle habits and freedom from symptoms and regained exercise tolerances.

**Methods:** We reviewed data from 2269 patients who had undergone CABG in the year 1990, 1993, 1998, 2000, 2001, 2002, or 2003. Data were collected with a questionnaire that addressed lifestyle modifications and their outcomes with regard to quality of life for up to 5 years after surgery.

**Results:** We observed significant decreases in changing dietary habits after surgery in patients who had surgery in 2000-2003 compared with patients who had surgery in 1990-1998 ( $15.9\% \pm 1.6\%$  vs  $24.7\% \pm 2.6\%$ ;  $P < .001$ ). In addition, the desire for nutritional counselling decreased steadily over time ( $35.1\% \pm 7.9\%$  vs  $26.6\% \pm 1.4\%$ ;  $P < .0001$ ). Notably, among patients 50-59 years old, fewer men than women followed a strict diet (males 20.0% vs females 41.5%;  $P = .001$ ). Patients suffering from recurrent angina consulted nutritionists more often than patients without angina ( $36.6\%$  vs  $29.8\%$ ;  $P = .016$ ). The more the patients were restricted in terms of physical fitness, as determined by the New York Heart Association (NYHA) class, the more likely they were to adhere to a healthy diet (NYHA III 22.2% vs NYHA II 14.6% vs NYHA I 10.2%;  $P < .001$ ). Among patients 60-79 years old, men exercised more often than women ( $72.4\% \pm 2.4\%$  vs  $51.1\% \pm 4.9\%$ ;  $P < .001$ ) and suffered less frequently from recurrent angina ( $13.4\% \pm 4.0\%$  vs  $28.8\% \pm 10.8\%$ ;  $P = .002$ ).

**Conclusions:** Despite knowledge of hypercholesterolemia or obesity as agents contributing to advancing coronary heart disease, attention to nutrition tends to significantly decrease over time in patients who have undergone CABG.

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Thus patients who have undergone CABG, especially male patients older than 50, years would benefit from dietary education. Similarly, female patients older than 60 years would benefit from increased physical activity. Patients obviously tend to delay lifestyle modification until symptoms occur. Hence they must be reminded of the importance of healthy nutrition and adequate physical activity.

### INTRODUCTION

The average age of patients undergoing coronary artery bypass grafting (CABG) procedures has significantly increased over the past decades. An important reason for this change, apart from an increase in preventative medical checkups and protective medication, is a change toward healthier lifestyles. In addition to the well-known first-line risk factors for coronary artery disease (CAD), such as lipometabolic disorder, hypertension, diabetes mellitus, and smoking, nutrition, and physical activity are also very important factors that influence the development of CAD. Many studies have shown that modification of these risk factors can prevent or reduce the progress of CAD [O'Connor 1989; Sacks 1996; de Lorgeril 1999; de Lorgeril 2006]. In addition, healthy lifestyle changes after surgery have proven beneficial in patients who have undergone CABG [Goldman 1989; Knatterud 2000; van Domburg 2000]. Based on these findings, the Task Force of the European Society of Cardiology and other societies involved in cardiovascular disease prevention have announced recommendations for the prevention of coronary heart disease in clinical practice [Pyorala 1994; Wood 1998]. Nevertheless, the management of modifiable risk factors in patients diagnosed with CAD has been shown to be suboptimal [Bowker 1996; EUROASPIRE 1997; EUROASPIRE II 2001]. With approximately 5000 CABG procedures performed annually in Switzerland and a proven impact of lifestyle changes on the secondary prevention of CAD, a clear need exists to elucidate the lifestyle changes that will lead to beneficial postoperative outcomes in CABG patients. We retrospectively evaluated the effects of postoperative changes in lifestyle habits during a period of 13 years in patients who had undergone CABG, with special focus on the correlation between lifestyle changes and freedom from symptoms or regained exercise tolerances.

## MATERIALS AND METHODS

### Study Population

The study population consisted of 2269 patients who had undergone CABG in the year 1990, 1993, 1998, 2000, 2001, 2002, or 2003 at the Zurich University Hospital or the Triemli City Hospital in Zurich, Switzerland. The responsible surgeons instructed patients according to international guidelines about the importance of plasma cholesterol reduction and smoking cessation. The postsurgery medication regimen, established immediately after surgery, included pravastatin, acetylsalicylic acid, and clopidogrel. Blood pressure was controlled and was assessed regularly 4 times a year by the family physician. A postsurgical cardiological examination was performed for the first time 3 months after surgery and repeated annually. Follow-up was conducted by means of a questionnaire mailed to the patients and by telephone communication with their physicians. The study was explained to the patients by means of a letter included with the questionnaire and a preamble at the beginning of telephone calls. By returning the letter or the answered questionnaire the patients showed their consent to participate in the study. Patients who died or did not respond to the questionnaire were excluded from this study. Thus 731 patients of 3000 were excluded, and a participation rate of 75.6% was reached. The mean time between surgery and evaluation was  $3 \pm 1.3$  years. The average age of the entire population studied was  $63.6 \pm 9.5$  years, and 86.2% of the evaluated subjects were male. The study was approved and permitted by the ethics committee of the Government of Zurich.

### Questionnaire Design

The questionnaire addressed the following aspects:

- Exercise tolerance in every day life, divided into 3 categories according to New York Heart Association (NYHA) classification, assessed according to patients' subjective descriptions.
- Freedom from angina pectoris (AP) after CABG procedure.
- Regular medical consultations/any reasons or need for medical intervention.
- Myocardial infarction during the follow-up period.
- Repeat surgery after previous CABG.
- Cardiological follow-up examination/ergometry.
- Cardiological reevaluation by means of cardiac catheter and/or percutaneous coronary intervention after CABG.
- Smoking status/time since cessation.
- Blood pressure (systolic/diastolic).
- Cholesterol/low-density lipoprotein (patients were divided into 4 categories on the basis of cholesterol concentrations: I,  $<4.5$  mmol/L; II, 4.5-4.9 mmol/L; III, 5.0-6.4 mmol/L; IV,  $\geq 6.5$  mmol/L).
- Medication.
- Dietary habits (special diet, nutrition consultation, postoperative change of diet, strict diet).
- Changed physical activity postoperatively.
- Regular physical activity (divided in 4 categories according to the frequency of getting exercise per week: never, once, 2-3 times, or every day); getting exercise was defined as all physical activity above the average level of everyday physical activity for the defined age group.

## STATISTICAL ANALYSIS

All statistical analyses were carried out using SPSS (SPSS Inc, Chicago, IL, USA). The numerical variables were expressed as mean  $\pm$  SD, categorical variables as percentages. The relationships between numerical variables were determined by use of the Mann-Whitney U Test and the  $\chi^2$  test for categorical variables. Statistical significance was considered at  $P < .05$ .

## RESULTS

During the course of this study, surgical techniques changed in regard to the use of off-pump vs on-pump CABG procedures: of the 2269 patients in this study, 1685 (60.9%) underwent the procedure using cardiopulmonary bypass (on-pump). The remaining procedures, mainly those performed since 1998, were conducted without cardiopulmonary bypass (off-pump). We observed no differences in age, sex, or patient outcomes (presence of AP symptoms or level of exercise tolerance) in patients who underwent on-pump vs off-pump surgery.

For evaluating the postoperative outcome subjectively, we used everyday exercise tolerance and freedom from AP symptoms.

### Exercise Tolerance

Exercise tolerance as reported by patients was categorized into 3 levels according to NYHA classification: level I, no cardiopulmonary restriction in everyday life; level II, cardiopulmonary restriction due to heavy work; and level III, cardiopulmonary restriction due to little effort exerted, or even at rest. Data regarding the association of patient parameters with exercise tolerance are presented in Tables 1 and 2.

We observed significant sex-related differences in patients' postoperative exercise tolerance; most of the male patients did not feel restricted in any way, whereas the females tended to see themselves as incapable of doing hard work (59.6% vs 47.6%,  $P < .01$ ).

As expected, there was a correlation between patient exercise tolerances as a subjective parameter and the need for cardiac catheterization as an objective parameter. Cardiac catheterization was performed in 7.3% of patients without any activity restrictions, 10.4% of patients with moderate restrictions, and 15.6% with distinct restrictions ( $P < .01$ ).

In regard to dietary changes, the data demonstrated that the strictness of patient diets increased in accordance with decreases in levels of physical fitness. The same was true for postoperative changes in physical training. Patients with lower exercise tolerance after CABG confirmed a change in the frequency of their physical training. Therefore, not

Table 1. Association of Patient Parameters with Exercise Tolerance

	Exercise Tolerance			P
	Level I	Level II	Level III	
Male	59.6%	35.5%	4.9%	<.01
Female	44.7%	47.6%	7.7%	
Cardiac catheterization	7.3%	10.4%	15.6%	<.01
Special diet	10.7%	14.6%	22.2%	<.005
Changing physical training postoperatively	38.5%	49.3%	67.8%	<.005
Physical training per week				
Never or once	20.8 % ± 6.58%	25.1% ± 11.67%	32.1% ± 28.85%	<.005
Twice or daily	29.3% ± 1.34%	25.0% ± 2.05%	17.9% ± 0.57%	

surprisingly, patients with distinct cardiopulmonary restrictions exercised less frequently.

**Freedom from AP Symptoms**

We found similar results in analyzing correlations to patient descriptions of AP symptoms. Female patients suffered more frequent AP symptoms postoperatively than male patients (23.8% vs 13.7%, *P* < .001). More patients who reported AP symptoms underwent coronary intervention after CABG than patients who were free of symptoms (11.9% vs 3.5%, *P* < .001).

In addition, 6.7% of patients with AP (n = 341) and 10.1% of patients without AP (n = 1929) were still smokers. Smoking cessation occurred in 92.7% of patients with AP and in 88.0% without AP. This distribution was statistically significant (*P* = .03). These results indicate that patients afflicted with AP symptoms are more likely to cease smoking than are patients without symptoms.

The same pattern held true regarding nutrition consultation: more patients with AP complied with the advice of nutritionists than did patients without AP symptoms (36.6% vs 29.8%, *P* < .05).

**Ergometry**

Ergometry is a standard method used to evaluate exercise tolerance in patients who have undergone CABG procedures. Regarding this tolerance test, we observed a significant difference between smokers and nonsmokers. Only 74.6% of the smokers underwent postoperative ergometry, whereas 84.9% of nonsmokers did so (*P* < .001). An possible explanation for this finding is lack of compliance

by smokers after CABG. Similar results were found in patient adherence to dietary modifications. Patients who consulted nutritionists underwent ergometry more often than those without professional nutritionist advice (90.1% vs 81.7%, *P* < .001).

**Age**

We evaluated age-dependent differences in patients, who were divided into 5 age groups: group I, 35-49 years; group II, 50-59 years; group III, 60-69 years; group IV, 70-79 years; and group V, 80 years and older.

Within group IV, we observed a significant difference between males and females receiving postoperative coronary angiography, with more female than male patients undergoing cardiac catheterization (11.6% vs 5.9%, *P* = .03). On the other hand, in this age group more males underwent ergometry than females (81.6% vs 63.3%, *P* < .001), a finding that suggests that older female patients are no longer physically capable of undergoing tolerance tests. Hence, female patients may benefit from earlier cardiac catheterization than male patients.

Regarding dietary restrictions, in group II more than twice as many female patients watched their nutrition strictly (13.4% vs 29.3%, *P* = .01).

In general, male patients reported feeling more physically fit than female patients, and males in groups III and IV exercised more often than females (72.4% ± 2.4% vs 51.1% ± 4.9%; *P* < .001).

**Changes from 1990 to 2003**

We observed 2 noteworthy trends during the course of this study: changes in dietary habits and in the use of nutritional consultation.

Compared to the 1990s, fewer CABG patients in 2000-2003 used nutritional consultation (35.1% ± 7.9% vs 26.6% ± 1.4%; *P* < .001). Hence, postsurgical patient changes in dietary habits decreased in 2000-2003 compared to 1990-1998 (15.9% ± 1.6% vs 24.7% ± 2.6%; *P* < .001).

**Cholesterol**

Patient cholesterol parameters were divided into 4 groups on the basis of cholesterol concentrations: I, <4.5 mmol/L; II, 4.5-4.9 mmol/L; III, 5.0-6.4 mmol/L; IV, ≥6.5 mmol/L.

Table 2. Association of Exercise Tolerance Levels with Cholesterol Concentrations

Cholesterol concentration	Exercise Tolerance			P
	Level I	Level II	Level III	
<4.5 mmol/L	52.7%	35.2%	12.1%	<.001
4.5-4.9 mmol/L	50.8%	40.8%	8.4%	<.001
5.0-6.4 mmol/L	42.5%	43.3%	14.2%	<.001
≥6.5 mmol/L	30.0%	36.7%	33.3%	<.001

In patients without any activity restrictions in everyday life, 54.3% were in group I, 23.8% of symptom-free patients were in group II, 20.4% in group III, and only 1.6% in group IV. This distribution was statistically significant ( $P < .001$ ). Most patients in groups I and II (51.8%) felt completely capable of performing everyday-life activities, whereas many patients in groups III and IV tended to be more and more restricted regarding hard work (40.0%) or even at rest (23.8%) ( $P < .001$ ) (Table 2).

Female patients tended to have higher cholesterol than male patients; more male than female patients belonged to group I (52.3% vs 39.3%,  $P < .001$ ), whereas more female than male patients belonged to group III (30.4% vs 22.6%,  $P < .001$ ). Furthermore, more female than male patients had cholesterol levels  $\geq 6.5$  mmol/L (7.4% vs 2.0% male,  $P < .001$ ) (Table 3).

## DISCUSSION

Evaluation of the observed data revealed that after CABG surgery, particularly in patients 60-79 years old, male patients felt significantly less restricted in everyday life than did female patients. In addition, more female than male patients suffered from postoperative AP. Differences between patient sex were associated with these 2 subjective parameters (exercise tolerance, AP symptoms) and the need for cardiac catheterization, including dilatation of coronary stenoses. A factor contributing to this finding is that females tend to be older than males when they develop CAD and may be less confident in their ability to participate in programs involving exercise [Dishman 1981; Lieberman 1998]. We suggest that one reason why female patients in the 70-79 year age group undergo more postoperative coronary angiographies than male patients is their increased restriction in physical activity compared to that of their male counterparts. Within this age group, many females are no longer capable of undergoing ergometry. Thus, this tolerance test often has to be skipped for females; thus cardiac catheterization is indicated earlier for verifying coronary stenoses. This finding may also explain the significant correlation between AP symptoms and percutaneous coronary dilatation. Without evaluation of verified AP by ergometry, more cardiac catheterizations are performed for diagnostic reasons, without the need for balloon dilatation.

Our data indicate that many postbypass patients do not follow strict diets until they suffer from physical activity restriction in everyday life. The same finding applies to patients with postoperative AP: for as long as patients are not afflicted with symptoms, they reject the consultation of

nutritionists. Although the correlation between dietary habits and mortality after myocardial infarction has already been demonstrated [Iestra 2006] and strong evidence remains that, for example, reduced saturated fat consumption decreases morbidity [Mead 2006], many patients who have undergone a CABG procedure tend to delay lifestyle modification until symptoms occur. This phenomenon is demonstrated by the numbers of patients still smoking postoperatively: many continue smoking as long as they are free from AP symptoms. The effect of smoking cessation on subsequent mortality is well known [van Domburg 2000], but even with the availability of information about smoking cessation [Burt 1974], underlining the importance of this lifestyle change remains necessary.

Concerning smoking and nutrition, another notable finding of our study was the observed lack of compliance in seeking follow-up examinations in patients who still smoke or who are deficient in dietary habits. The proportion of patients undergoing tolerance tests was greater among nonsmokers than among smokers, a statistically significant difference. A similar difference between patients consulting nutritionists and those not doing so was seen; whereas a significantly more followed professional advice. In this regard, more women than men followed a strict diet, especially in the 50 to 59 year age group. Over the duration of this study there has been a noticeable trend toward a decrease in changing dietary habits, with less consultation with nutritionists.

One risk factor for cardiovascular diseases is hypercholesterolemia. Many studies have shown that a consistent lipid-lowering therapy could positively influence mortality and morbidity of CABG and myocardial infarction patients [Pravastatin Multinational Study Group for Cardiac Risk Patients 1993; Scandinavian Simvastatin Survival Study. 1994]. Therapeutic drug use and a strict diet are 2 well-known ways of lowering cholesterol levels. Astonishingly, females who naturally pay more attention to their nutrition have higher average cholesterol levels than men. Women are also less likely than men to receive lipid-lowering medication [Di Cecco 2002]. Perhaps that is a reason why male patients feel so much physically fitter than female patients of the same age. In this regard, the collected data show that patients with higher cholesterol levels feel more and more restricted in everyday life.

Over the years, patients who have received CABG tend to pay significantly less attention to their diet, despite their knowledge that hypercholesterolemia and obesity lead to coronary heart disease. In particular male patients older than 50 years would benefit from dietary education after CABG. Similarly, women older than 60 years of age might profit from more physical activity. Patients obviously tend to delay lifestyle modification until symptoms occur. Hence, a need

Table 3. Cholesterol Concentrations according to Patient Sex

Sex	Cholesterol Concentration				P
	<4.5 mmol/L	4.5-4.9 mmol/L	5.0-6.4 mmol/L	$\geq 6.5$ mmol/L	
Female	39.3%	23.0%	30.4%	7.4%	<.001
Male	52.3%	23.1%	22.6%	2.0%	<.001

exists for underlining the importance of healthy nutrition and adequate physical activity.

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