Original Paper

Effects of Long-Term and Ongoing Cardiac Rehabilitation in Elderly Patients With Coronary Heart Disease

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The authors assessed the effect of very long-term cardiac rehabilitation (over 1 year) on exercise tolerance and coronary heart disease risk factors in patients older than 80 years with coronary heart disease relative to an elderly cohort without coronary heart disease. Included in this retrospective analysis were patients older than 80 at the time of their last evaluation who had completed at least 1 year of a cardiac prevention and exercise training program. A total of 43 coronary heart disease patients and 15 age-matched healthy subjects were included in this study. Long-term cardiac rehabilitation in very elderly coronary heart disease patients was shown to be feasible and effective in improving functional capacity (+5.4% after 1 year; P<.05) and risk factor control, and slowing the decline in exercise tolerance that occurs with normal aging. (AJGC. 2006;15:345–351) ©2006 Le Jacq

The progressive aging of the population in industrialized countries and the improving survival of patients with coronary heart disease (CHD) has created a large population of older adults (65 years and older) eligible for cardiac rehabilitation programs.[1,2] Given the prevalence of CHD in the elderly and the increasing mean age of patients with documented CHD, elderly patients with CHD will represent an increasing proportion of cardiac rehabilitation candidates in the future.[1,3] The benefits of cardiac rehabilitation programs have been well documented in young and middle-aged patients with CHD and include improvements in maximal and submaximal exercise capacity, coronary risk factors, quality-of-life, and psychological parameters.[1,4,5] Several studies of cardiac rehabilitation have shown improvements in morbidity and mortality in post–myocardial infarction, stable CHD, and chronic heart failure patients.[6–9] Elderly patients with CHD have higher rates of physical disability, including decreased physical fitness, diminished muscular strength, more severe exertional dyspnea, and higher depression scores.[4,10,11] These disabilities reduce functional capacity and lead elderly patients to the minimum level of physical fitness required to perform activities of daily living.[3] Despite these observations, cardiac rehabilitation programs have rarely targeted elderly patients with CHD.[1,4] Elderly CHD patients are less likely to be referred to cardiac rehabilitation programs.[12] Although potentially beneficial, the effects of long-term cardiac rehabilitation on exercise tolerance and risk factors in elderly CHD patients have not been well documented, and even less attention has been focused on the very old (80 years and older). The aim of the present study was to describe the cardiac rehabilitation experience in CHD patients 80

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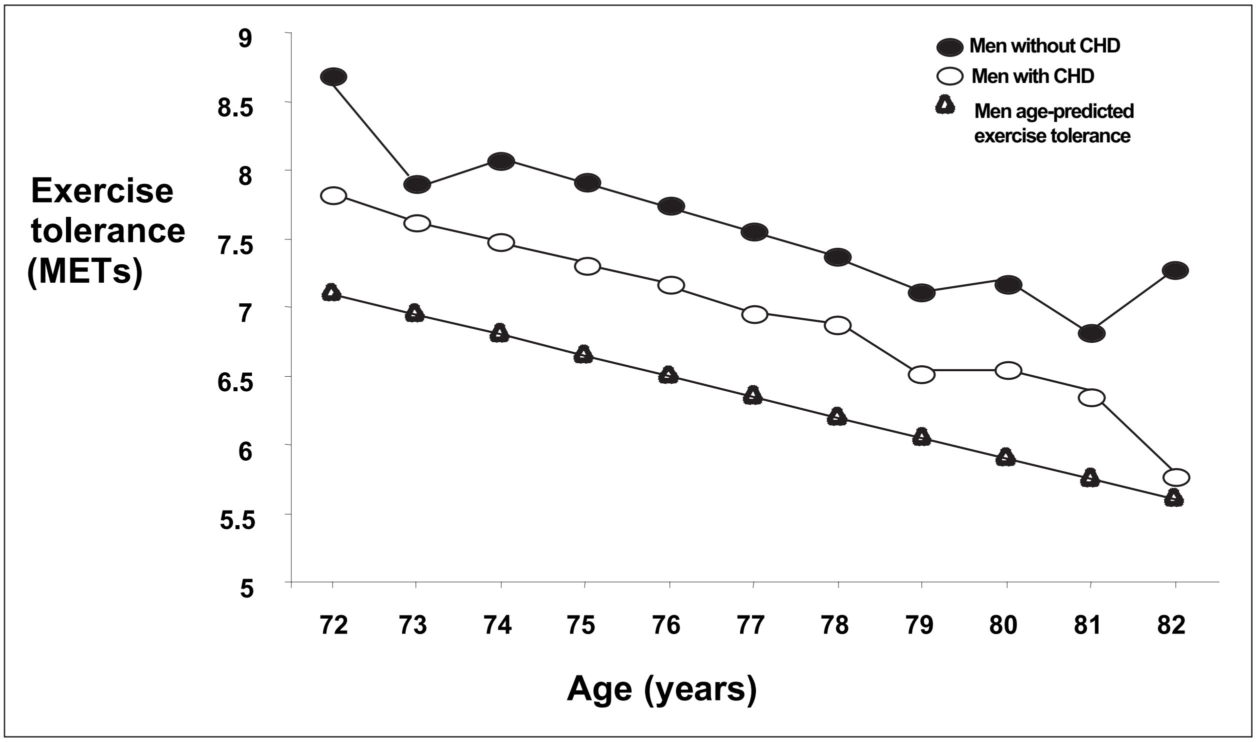

Figure. Exercise tolerance as a function of age during very long-term cardiac rehabilitation/prevention programs in elderly men with (n=38) and without (n=10) coronary heart disease (CHD). Age-predicted values for men based on equation: exercise tolerance (in metabolic equivalents [METs]) = 18.00 – 0.15 × age. Adapted with permission from Morris et al.[16]

years and older who are currently participating in the cardiac rehabilitation program of our institution. We compared this very elderly CHD cohort with an aged-matched healthy elderly population currently participating in the same prevention and exercise training program.

METHODS

Study Population. This retrospective chart review was conducted at the cardiac prevention and rehabilitation center of the Montreal Heart Institute (EPIC). EPIC provides a multiphase, multidisciplinary approach to the primary, secondary, and tertiary prevention of cardiovascular disease. We included all patients 80 years and older currently participating in a cardiac rehabilitation or cardiac prevention program and having completed at least 2 exercise stress tests (pre- and post-training) for evaluation of exercise tolerance. We identified 43 elderly patients with CHD (38 men and 5 women) and 15 elderly subjects without CHD (10 men and 5 women), the data for whom are included in this study (except in the Figure, where only men were considered). Inclusion criteria for CHD patients consisted of the presence of documented CHD (prior myocardial infarction, prior coronary angioplasty, coronary bypass surgery, or documented myocardial ischemia on myocardial scintigraphy), age 80 years or older, and current participation (as of April 2004) in our cardiac rehabilitation program. The non-CHD elderly cohort included subjects 80 years or older currently participating in our cardiac prevention and exercise training program.

Exercise Training and Risk Factor Intervention. Subjects in both the cardiac rehabilitation and prevention groups underwent the same aerobic training program at an exercise intensity corresponding to 65%–90% of their maximal heart rate based on the initial and subsequent exercise stress tests. Supervised exercise training according to recent recommendations[1,13] was performed at least 2 times per week for 40 minutes per session (5 minutes of warm-up, 30 minutes of aerobic exercise, and 5 minutes of cool-down) in different activities such as walking, stationary cycling, and rowing. Patients received dietary advice regarding a low-fat diet from nurses and physicians, generally on a yearly basis. In addition, formal dietary and psychological counseling and a smoking cessation program were available for subjects, if deemed necessary.

Patient Follow-Up, Exercise Stress Testing, and Risk Factor Analysis. From baseline evaluation to the end of the follow-up period, patients were evaluated every 6–12 months by a cardiologist. Variables measured included body mass index (BMI), blood pressure (BP), fasting glycemia, and lipid profile (total cholesterol, low-density lipoprotein cholesterol [LDL-C], high-density lipoprotein-cholesterol [HDL-C], triglycerides, and total cholesterol/HDL-C ratio). An exercise stress test was also performed at each visit. Subjects were classified as having diabetes if their fasting glucose was ≥126 mg/dL or if they were receiving medical therapy for diabetes (insulin or oral agents). Hypertension was defined as a systolic BP ≥140 mm Hg and/or diastolic BP ≥90 mm Hg, or if patients were receiving antihypertensive therapy. Abdominal obesity was defined as BMI >27 kg/m^2.[14] Presence of dyslipidemia was defined as a medical history of dyslipidemia, use of lipid-lowering therapy, or an LDL-C >100 mg/dL and total cholesterol/HDL-C ratio >4 in patients not receiving statins.[15] Treadmill exercise testing was performed using a symptom-limited ramp protocol (Series 2000, Marquette Treadmill and Marquette ECG Case 12, GE Healthcare, Laurel, MD).[13] During the tests, the subject's electrocardiogram and BP were monitored continuously. Maximal exercise tolerance was defined as the highest level of metabolic equivalent units (METs) estimated from maximal treadmill speed and grade during the treadmill test.[14] All patients were instructed to take their usual medications before exercise testing.

Table I. Characteristics of Elderly Subjects With and Without Coronary Heart Disease (CHD) at Last Evaluation

	Prevention (No CHD) (n=15)	Rehabilitation (CHD) (n=43)
Age, y	83±3	82±1
Duration of cardiac rehabilitation, y	13±5	12±5
Program attendance, sessions/wk	2.6±0.5	2.8±0.85
Female sex	5 (33)	5 (13)
Smoking	0 (0)	2 (5)
Hypertension	5 (33)	19 (44)
Diabetes	2 (13)	19 (44)
Dyslipidemia	6 (40)	38 (88)
Abdominal obesity	5 (33)	20 (47)
Prior myocardial infarction	0 (0)	23 (53)
Prior PCI	0 (0)	11 (26)
Prior CABG	0 (0)	13 (30)
Angina pectoris	0 (0)	14 (33)
Pacemakers	0 (0)	1 (2)
Lipid-lowering therapy	3 (20)	30 (70)
ACE inhibitors	2 (13)	9 (21)
β-Blockers	1 (7)	19 (44)
Antiplatelet agents	4 (27)	37 (86)

Data are presented as mean ± SD or number (percentage). PCI indicates percutaneous coronary intervention; CABG, coronary artery bypass grafting surgery; and ACE, angiotensin-converting enzyme.

Program Attendance. Data on program attendance were obtained from the patient's EPIC medical chart when available. Patients were also contacted by phone and asked to recall the number of training sessions usually performed on a weekly basis and whether the frequency of training sessions had changed since the beginning of their entry into the program. EPIC also possesses an electronic entry system that recorded patient entry into the center for a 1-year period. As such, patient entry data were available for the period April 2003–April 2004.

Statistical Analyses. All data are expressed as mean value ± SD and/or in number and percentage. Statistical differences between groups and time were evaluated by a 2-way analysis of variance with one repeated measure (time) followed by a pairwise comparison when the global analysis of variance was significant. All analyses were performed using SAS release 8.2 (SAS Institute, Inc, Cary, NC). A P value of ≤.05 was considered statistically significant.

RESULTS

Subjects' Characteristics. Table I describes the clinical characteristics of both elderly cohorts at the time of their last evaluation. Mean age was approximately 82 years in both groups. The median duration of cardiac rehabilitation and prevention programs was similar in both groups (15 and 14 years, respectively), with a range of 1–26 years in the cardiac rehabilitation group. Program attendance within the past year was also similar in both groups (mean attendance, 2.6 vs 2.8 sessions/week for CHD and non-CHD groups, respectively). The prevalence of traditional risk factors was higher in the CHD cohort, with approximately half having a history of prior myocardial infarction and one third having a history of coronary revascularization. The majority of CHD patients were treated with antiplatelet agents and statins.

Table II. Metabolic Risk Factors in Elderly Subjects With and Without Coronary Heart Disease (CHD) at First and Last Evaluation

	No CHD (n=15)		CHD (n=43)		
	First	Last	First	Last	P
Weight, kg	67±10	66±12	72±10	71±11	NS
Body mass index, kg/m²	24.9±3.2	24.8±3.6	26.2±3.1	25.8±3.2	NS
Fasting glucose, mg/dL	98±7	101±12	101±10	105±12	<.05*
Total cholesterol, mg/dL	243±33	201±34	216±15	170±30	<.01† <.0001*
High-density lipoprotein (HDL) cholesterol, mg/dL	58±16	65±20	46±14	52±13	<.01† <.01*
Low-density lipoprotein cholesterol, mg/dL	154±27	113±28	137±40	91±23	<.05† <.0001*
Total/HDL cholesterol	4.47±1.42	3.29±0.93	5.13±2.12	3.43±0.82	<.0001*
Triglycerides, mg/dL	147±125	115±46	160±103	130±65	<.05*

Data are presented as mean ± SD. NS indicates nonsignificant. *First vs last evaluation. †CHD vs non-CHD patients.

Table III. Exercise Parameters in Elderly Subjects With and Without Coronary Heart Disease (CHD) at Baseline, 1 Year, and Final Evaluation

	No CHD (n=15)			CHD (n=43)			
	First	1 Year	Last	First	1 Year	Last	P
Exercise capacity (METs)	8.06±1.52	7.78±1.27	6.52±1.49*	7.21±1.72	7.6±1.53†	5.83±1.73*	<.0001* <.01† <.05‡
Resting HR, bpm	76±14	75±14	69±13*	70±12	71±17	67±12*	<.05*
Resting SBP, mm Hg	129±11	131±18	137±19	133±21	136±22	134±15	NS
Resting DBP, mm Hg	77±6	75±11	79±21	77±15	79±9	76±7	NS
RPP_{max} (HR × SBP)/100	285±56	278±44	228±53*	251±68	248±70	195±52*	<.05§ <.0001*

Data are presented as mean ± SD. METs indicates metabolic equivalents; HR, heart rate; SBP, systolic blood pressure; DBP, diastolic blood pressure; RPP_{max}, maximum rate–pressure product. *First vs last evaluation. †First vs 1 year. ‡Interaction group × time; §CHD vs non-CHD patients.

Coronary Risk Factors. No differences were found with respect to weight or BMI, and patients were generally lean or only mildly overweight (Table II). Fasting glucose levels increased significantly over time in both groups, as did HDL-C levels. Total cholesterol, LDL-C, and triglyceride levels decreased significantly over time in both cohorts. Sixty percent of patients in the cardiac rehabilitation group had attained the target LDL-C level (≤100 mg/dL) by the last evaluation. While 3 subjects in the non-CHD group were taking lipid-lowering therapy, results were similar after their exclusion (data not shown).

Exercise Stress Testing Data. Exercise testing data are shown in Table III. As expected, functional capacity increased after the first year of cardiac rehabilitation in CHD patients. Exercise tolerance, which was already higher at baseline in non-CHD patients, remained stable during the first year. In both groups, over the 12–13-year follow-up period, exercise tolerance decreased steadily, the decline being more pronounced in CHD patients (P=.0303 for interaction). Maximum heart rate and maximum rate–pressure product decreased over time, but more so in CHD patients, indicative of both time and group effects.

Chronic Exercise, Aging, and Functional Capacity. To better understand the influence of chronic exercise on the normal decline of functional capacity with age in elderly patients, we examined exercise tolerance in men with CHD (n=39) and men without CHD (n=10) who had undergone a minimum of 2 years of exercise training (Figure). Women were excluded because of their low number and to allow comparison with published age-dependent norms.[16,17]

Exercise tolerance decreased significantly in both groups, although the reduction was slightly more pronounced in men with CHD, indicative of both time and group effects (P=.0165 for interaction). The rate of decline in functional capacity was approximately –2.2%/y or –0.18 METs/y in elderly CHD and approximately –1.3%/y or –0.11 METs/y in non-CHD patients over a 10-year span (from a mean age of 72 to 82 years). Exercise tolerance in both groups was higher than that expected according to published age-dependent norms.[16,17]

DISCUSSION

Current estimates suggest that in the United States, the number of octogenarians is expected to increase by 65% between 2000 and 2025, to reach 14 million people.[18] Given the prevalence of CHD in individuals older than 80 years, preventive measures are essential to improve the health of elderly CHD patients and simultaneously reduce health care costs. Despite these facts, the potential health benefits of cardiac rehabilitation in elderly CHD patients have so far received relatively little attention in the scientific literature, the current recommendations being based on a smaller body of evidence relative to the exercise guidelines developed for nonelderly patients with CHD.[4,19]

Our data suggest that the majority of CHD patients 80 years and older currently enrolled in cardiac rehabilitation programs are individuals who began their program at a significantly earlier age and have continued to participate in such programs despite their advancing age. Very elderly CHD patients may be reluctant to initiate a program following a coronary event, which is consistent with data showing poor recruitment rates of elderly patients into secondary prevention programs.[1,20] Poor recruitment rates of elderly CHD patients reflect several factors, including a lack of recognition of both patients and caregivers of the beneficial effects of cardiac rehabilitation programs on health, economic and logistic reasons, and the limited number of centers offering inexpensive, community-oriented programs.[1] Additionally, the majority of participants in both our groups were men, reflecting the further difficulty of recruiting women into cardiac prevention programs.[21] Nevertheless, our findings do demonstrate that long-term cardiac rehabilitation in very elderly CHD patients is feasible and effective in maintaining functional capacity and enhancing risk factor control.

Several recent studies have demonstrated improvements in functional capacity and cardiac risk factors in elderly CHD patients undergoing short-term cardiac rehabilitation programs lasting from 2 to 12 weeks.[3,22] Two recent brief reports[3,19] have demonstrated improvements in functional capacity and cardiac risk factors in elderly CHD patients (older than 75 years) undergoing short-term cardiac rehabilitation programs lasting from 2 to 4 months. Our study is the first to examine the effects of a very long-term cardiac rehabilitation program (mean duration, 12±5 years) on similar parameters in very elderly CHD patients 80 years and older.

We observed a significant increase in exercise capacity in our cardiac rehabilitation group after the first year of exercise training (+5.4%; P<.01), consistent with previously published literature.[23] In studies with shorter training duration, improvements in exercise tolerance have also been noted, ranging from 20%–40%.[3,20,22,24,25] In our cardiac prevention cohort, exercise tolerance was maintained during the first year of exercise training but did not improve. Possible reasons for the lack of training effect include a high exercise tolerance at baseline (8 METs), insufficient intensity and frequency of exercise training, and a higher proportion of men having a higher baseline exercise tolerance compared with women.[2] In addition, men may require a higher training intensity to significantly improve exercise capacity after 1 year.[26–29]

CHD patients had lower baseline functional capacity, and exercise tolerance decreased significantly with age in both groups, although the reduction was slightly more pronounced in CHD vs non-CHD patients. Longitudinal exercise tolerance data showed that the rate of decline of functional capacity was approximately 2.2%/y in elderly men with CHD compared with approximately 1.3%/y in men without CHD over a 10-year span (from a mean age of 72 to 82 years). A recent 4-year study[30] in healthy elderly subjects (mean initial age, 64±1 year) showed an exercise tolerance reduction of 0.28%/y in the high-training group, 2.6%/y in the moderate-training groups, and 4.6%/y in the low-training group. Despite the fact that our subjects were older and one cohort had a diagnosis of CHD, our data are comparable to those observed in the moderate-training group in the previously mentioned study.[30,31] Exercise tolerance was higher in both men's groups in the present study relative to published age-dependent norms.[16,17]

As expected, we observed beneficial effects of our cardiac rehabilitation and prevention programs on coronary risk factors in both elderly cohorts (Table II). By the most recent evaluation, 70% of elderly CHD patients were receiving statin therapy and most had achieved target LDL-C levels (≤100 mg/dL). These data confirm that patients were generally being treated according to the most current lipid-lowering guidelines available during each follow-up visit. Among elderly subjects without CHD, we also observed a significant improvement in the lipid profile, including a 17% reduction in total cholesterol and a 26% reduction in LDL-C. Possible explanations for these improvements include the combination of regular exercise,[32] diet,[33,34] and the aging process.[35–38]

Our subjects were generally of normal weight or only slightly overweight. Our long-term exercise training programs did not show any effect on weight or BMI, which was consistent with previous studies.[3,23,24] While the best weight-loss results are achieved with a combination of diet and exercise, this approach provides only modest improvements in elderly CHD patients.[4]

The interpretation of our findings requires several considerations. First, our study represents the experience of one institution's efforts to provide long-term cardiac rehabilitation and prevention programs to elderly and very elderly patients with and without CHD. Our elderly cohorts represent a select group of patients who do not necessarily reflect the cardiac rehabilitation experience in the general elderly coronary population. Nevertheless, our data suggest that a cardiac rehabilitation program begun in the sixth and seventh decades of life leads to high functional capacity and risk factor control in those who continue to follow the program into their eighth decade. Second, we did not possess an elderly CHD control group in our study to evaluate the effect of a cardiac rehabilitation program on exercise tolerance and risk factor control relative to usual care. However, we did compare our cardiac rehabilitation group to a relatively fit, elderly, cohort without CHD undergoing a similar program. We were able to demonstrate that exercise tolerance in men in both cohorts was superior to predicted values based on age. Third, the sample size of both cohorts was small, particularly for the non-CHD group; however, the subjects we did include represent patients who were followed regularly for many years and in whom a significant amount of complete data were available. Finally, most of our subjects were men, the effects of cardiac rehabilitation perhaps being different in elderly women with and without CHD.

CONCLUSIONS

Our results show the feasibility and beneficial effects of a long-term cardiac rehabilitation/prevention program in the primary and secondary prevention of CHD in elderly and very elderly subjects. Based on our data, elderly subjects with an acute coronary syndrome or undergoing coronary revascularization should be referred to a phase II cardiac rehabilitation program and encouraged to continue exercising regularly afterwards. Chronic exercise, 2 or 3 times per week, seems sufficient to maintain exercise tolerance at significantly higher values than expected, although the rate of decline in functional capacity with aging appears largely unchanged. Whether in the context of a comprehensive cardiac rehabilitation program or not, cardiac risk factors should be treated aggressively in very elderly CHD subjects, and significant improvements appear achievable. Prospective studies are now required to evaluate the benefit of long-term cardiac rehabilitation in octogenarians with CHD.

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