



AMERICAN COLLEGE
of **SPORTS MEDICINE**

POSITION STAND

Exercise for Patients with Coronary Artery Disease

SUMMARY

American College of Sports Medicine Position Stand: "EXERCISE FOR PATIENTS WITH CORONARY ARTERY DISEASE." *Med. Sci. Sports Exerc.*, Vol. 26, No. 3, pp. i-v, 1994. Exercise training improves functional capacity and reduces clinical symptoms in patients with coronary artery disease. However, such patients are at increased risk for cardiovascular complications during exercise; therefore, appropriate safeguards should be employed to minimize these risks. Based on the documented benefits and risks of exercise for patients with coronary artery disease, it is the position of the American College of Sports Medicine that most patients with coronary artery disease should engage in individually designed exercise programs to achieve optimal physical and emotional health.

INTRODUCTION

This position stand will address exercise for patients with coronary artery disease. The following points are readily recognized. Patients with coronary artery disease are not a homogeneous group and must be considered individually. They vary greatly in their clinical status including: extent of coronary artery disease, left ventricular dysfunction, potential for myocardial ischemia, and presence of cardiac arrhythmias. Some patients with coronary artery disease have had prior cardiac events (e.g., myocardial infarction, cardiac arrest) or treatments (e.g., coronary artery bypass graft surgery, percutaneous transluminal coronary angioplasty, or other coronary artery interventions). Many patients have additional medical disorders including hypertension, peripheral vascular disease, valvular heart disease, chronic obstructive pulmonary disease, and diabetes mellitus.

Exercise in the outpatient setting will be addressed in this position stand, although in-hospital, early ambulation following cardiac events is also important.

EFFECTS OF EXERCISE TRAINING

Functional Capacity

Patients with coronary artery disease generally demonstrate reduced maximal oxygen uptake and exercise tolerance compared with their healthy contemporaries. The magnitude of the reduction varies in part with the severity of disease, and some coronary artery disease patients have normal exercise tolerance. Both a lower maximal stroke volume and heart rate may limit maximal **cardiac output** and oxygen uptake (7). The magnitude of the reduction in stroke volume depends on the amount of

myocardium rendered ischemic by exercise and/or the size of prior myocardial infarction. The mechanism for the reduced exercise heart rate in unmedicated patients has not been defined. Maximal exercise performance in patients with angina pectoris is limited by discomfort. In patients with classic angina pectoris, such discomfort occurs at a highly reproducible (25) rate pressure product (heart rate times systolic blood pressure) if factors such as time of day, room temperature, and body position are constant (6). Many patients do not demonstrate this classic pattern, suggesting that coronary vasospastic changes contribute to the variation in their anginal threshold (42).

Both the patient's behavior and the physician's recommendations may also reduce the patient's exercise capacity. Detraining occurs both from self-induced and medically required restrictions in activity. Medications such as beta adrenergic blockers, although beneficial for symptomatic patients, may reduce exercise capacity in some patient groups, especially if these drugs are prescribed routinely or prophylactically in asymptomatic patients.

Exercise training increases functional capacity and maximal oxygen uptake ($\dot{V}O_{2max}$) in coronary artery disease patients by increasing the arteriovenous oxygen difference, and in some cases maximal stroke volume as well (7). The relative contribution of these two factors to the increase in $\dot{V}O_{2max}$ varies with the patient population and type of training program. The increase in $\dot{V}O_{2max}$ in coronary artery disease patients after three months of training ranges from approximately 10–60% in published reports and averages about 20% (16,39). Increases in maximal work capacity may underestimate the functional benefits of exercise training, because marked increases in submaximal endurance capacity can occur in healthy subjects despite modest increases in $\dot{V}O_{2max}$ (35).

Symptoms of Myocardial Ischemia

Some of the greatest increases in effort tolerance following exercise training occur in patients with angina pectoris (8). Exercise training reduces submaximal heart rate at any given workload or activity and delays the onset of symptoms during exercise. Some patients actually have a disappearance of anginal pain after training (8). The reduction in anginal symptoms produced by exercise training may facilitate a decrease in drug therapy, but this benefit of exercise training has not been well quantified.

Myocardial Ischemia and Perfusion

Despite improved exercise performance and reduced symptoms in coronary artery disease patients, there is no conclusive evidence that exercise training alone increases vessel caliber, augments collateral development, or reverses coronary narrowing (12,39). **Increased** coronary diameter after exercise training has **been** documented in animal models of diet-induced atherosclerosis (23). Furthermore, some exercise training studies observed increases in the rate pressure product at the onset of ischemia and reduced ST segment depression at similar rate pressure products, implying enhanced coronary flow (10), but these improvements are not found universally. Thallium-201 scintigraphy has documented improved myocardial perfusion in some patients after training (14). The role of reduced coronary constriction was not evaluated in these reports, and angiographic studies have failed to demonstrate changes in resting coronary caliber or collaterals (39). Consequently, although coronary perfusion may be improved in some patients by exercise training, the mechanism remains undefined (12).

Coronary Artery Disease Risk Factors

Blood lipids. Increased levels of low-density lipoprotein (LDL) cholesterol and depressed levels of high-density lipoprotein (HDL) cholesterol are key risk factors for the development of coronary artery disease. Recent studies also demonstrate the importance of modifying these lipoproteins in secondary coronary artery disease prevention (20). A meta-analysis of the eight clinical trials of cholesterol reduction in myocardial infarction survivors performed from 1965-1988 demonstrates a 16% reduction in fatal and a 25% reduction in nonfatal myocardial infarctions in the treated group (34). Cholesterol treatment consisted of diet alone in three and diet plus medication in five of these studies. None of these trials, however, directly involved an exercise rehabilitation program nor, with rare exceptions (19), have comprehensive exercise rehabilitation programs examined the relationship of lipid changes and survival. A meta-analysis of 15 reports on the effect of exercise training in postmyocardial infarction patients has shown significant reductions of total cholesterol, LDL-cholesterol, and triglycerides; and an increase in HDL-cholesterol with training (40). These results suggest that comprehensive cardiac rehabilitation programs utilizing exercise, diet, and medication, when appropriate, would beneficially alter lipids and patient prognosis.

Cigarette smoking. Cigarette smoking is a well-recognized, major risk factor for coronary artery disease, particularly sudden cardiac death. Furthermore, men who survive a myocardial infarction and quit smoking have a 19% mortality rate over the next 6 yr, whereas the mortality rate is 30% in those who continue smoking (36). A study of the effects of exercise training on smoking in

patients recovering from acute myocardial infarction suggests that formal rehabilitation programs facilitate smoking cessation and cessation maintenance in cardiac patients (38), but firm support for this conclusion is not available.

Hypertension control. Uncontrolled hypertension doubles or triples the risk of cardiovascular events, and elevated blood pressure is an independent predictor of subsequent morbidity and mortality in survivors of **myocardial** infarction (21). Effective control of elevated blood pressure in the myocardial infarction population reduces cardiovascular mortality by 20% (24). Exercise training can contribute to blood pressure control (15), but optimal blood pressure control is usually achieved by pharmacological therapy. Exercise training may contribute to hypertension management indirectly through weight reduction, but its independent contribution to blood pressure control in coronary artery disease patients has not been well documented.

Glucose intolerance and diabetes mellitus. **Glucose** intolerance and diabetes mellitus are major risk factors for cardiovascular disease. Unfortunately, control of diabetes has not been shown to beneficially affect the development of coronary artery disease. Physical activity can help to control hyperglycemia especially when combined with weight loss (26). Such physical activity should be of benefit to glucose control in coronary artery disease patients.

Control of obesity. Obesity is an independent risk factor for the development of coronary artery disease (18). Obesity is also associated with hypertension, **glucose** intolerance, and unfavorable lipid profiles (27). Successful weight loss is a benefit of an exercise training program and should contribute to reduced cardiovascular morbidity and mortality (19,28,43).

Psychological benefits. Patients undergoing either an exercise program or an exercise and counseling program have been reported to demonstrate an improved quality of life compared with control groups (32). Furthermore, exercise training has been documented to reduce depression in clinically depressed patients following an acute myocardial infarction (37). Such psychological changes could be a major benefit to patients with coronary artery disease involved in exercise training programs, but two recent studies have failed to document psychological benefits (5,31).

Cardiovascular mortality. Published studies have documented the beneficial effects of cardiac rehabilitation programs in reducing subsequent coronary artery disease mortality (29,30). Compared with control groups, patients assigned to exercise-based rehabilitation programs experienced a 20–25% reduction in fatal cardiovascular events and total mortality. These analyses did not demonstrate differences in nonfatal recurrent events. Also, the contribution of exercise training to survival of patients following coronary artery bypass graft surgery

and percutaneous transluminal coronary angioplasty has not been evaluated. Nevertheless, these mortality results suggest that exercise training is one of the few interventions documented to increase survival after myocardial infarction.

Cost benefit. The cost benefit analysis of exercise rehabilitation in patients following myocardial infarction or bypass surgery has not been well studied. Nevertheless, significant reduction in medical care costs in patients choosing to participate in an exercise-based cardiac rehabilitation program compared with nonparticipants has been reported (1). In another study, patients undergoing cardiac rehabilitation following percutaneous transluminal coronary angioplasty experienced fewer hospital readmissions and a reduction in overall medical expenses compared with patients not receiving rehabilitation (9). Such preliminary results suggest that the financial benefits of cardiac rehabilitation outweigh its monetary cost.

RECOMMENDATIONS

Evaluation

Before beginning an exercise program, patients with coronary artery disease require a complete medical history, physical examination, and a graded exercise test (4,11). The initial evaluation is directed at the patient's cardiovascular as well as general medical and orthopedic status. Further evaluation, if clinically indicated, is directed at defining any pathophysiological abnormalities, including left ventricular dysfunction, myocardial ischemia, or cardiac arrhythmias. Abnormalities identified may then be managed medically or surgically prior to beginning the exercise program.

Patients identified as high risk for cardiovascular complications during exercise include patients with unstable angina, severe aortic stenosis, uncontrolled cardiac arrhythmias, decompensated congestive heart failure, or other medical conditions that could be aggravated by exercise (e.g., acute myocarditis or infectious disease) (11). These patients should defer exercise training until the above problems are controlled.

Patients at increased risk who may be able to exercise under direct medical supervision include those with (2,11,17): i) Severely depressed left ventricular function; ii) resting complex ventricular arrhythmias; iii) ventricular arrhythmias appearing or increasing with exercise; iv) decrease in systolic blood pressure with exercise; v) survivors of sudden cardiac arrest; vi) recent myocardial infarction complicated by congestive heart failure; and vii) marked exercise-induced ischemia. It should be noted; however, that the risk to benefit ratio of exercise training for such patients is not defined.

The exercise prescription, especially in terms of exer-

cise intensity and degree of monitoring and supervision, is also based on the initial clinical and exercise evaluation.

Reevaluation should be performed regularly and as clinically indicated, generally 2-3 months after starting a program, and then at least yearly thereafter (11). It is important to assess the physiologic changes resulting from an exercise program as well as the possibility of disease progression.

Exercise Prescription

Exercise for patients with coronary artery disease includes activities performed in formal supervised exercise programs, as well as everyday physical activities. Therefore, general daily activity is encouraged in addition to formal exercise sessions.

The exercise program for the patient with coronary artery disease is based on the traditional prescription for developing a training effect in healthy persons (3). It is, however, modified as indicated by the patient's cardiovascular and general medical status. It involves an individually appropriate program of exercise with respect to mode, frequency, duration, intensity, and progression of exercise (3,4,11).

Mode. Large muscle group, continuous exercise, such as walking, jogging, bicycling, swimming, group aerobics, and rowing, is appropriate for cardiovascular endurance conditioning. Upper extremity exercises performed with arm ergometers may also be utilized for those who cannot tolerate lower extremity activity for orthopedic or other reasons, and for patients whose occupational or recreational activities are dominated by arm work. Strength training is also beneficial for selected patients (13). Resistance exercises generally are performed with a circuit training approach, up to 10-12 exercises using 10-12 repetitions of resistances that can be performed comfortably (22). Cross-training may also help to reduce musculoskeletal problems and increase compliance.

Frequency. Minimum frequency is three nonconsecutive days per week. Some patients prefer to exercise daily. However with increased frequency of exercise, the risk of musculoskeletal injury increases (33).

Duration. Warm-up and cool-down periods of at least 10 min, including stretching and flexibility exercises, should precede and follow 20-40 min of cardiovascular exercise performed either continuously or through interval training. The latter may be especially useful for patients with peripheral vascular disease and intermittent claudication.

Intensity. Exercise in supervised programs is performed at a moderate, comfortable intensity, generally 40-85% of maximal functional capacity ($\dot{V}O_{2max}$), which correlates with 40-85% of maximal heart rate reserve ($[\text{maximal heart rate} - \text{resting heart rate}] \times 40-85\% + \text{resting heart rate}$), or 55-90% of maximal heart rate.

Ratings of perceived exertion (RPE) may also be used to monitor exercise intensity, with the goal of keeping the intensity at a moderate level. The exercise intensity should be below a level that provokes myocardial ischemia, significant arrhythmias, or symptoms of exercise intolerance as judged clinically or by exercise testing.

The recommended intensity of exercise training varies with the degree of supervision available and the patient's level of risk. Lower exercise intensities are indicated for higher risk patients (defined above) especially when exercising outside of supervised programs or without continuous ECG monitoring.

Progression. Any exercise program for patients with coronary artery disease should involve an initial slow, gradual progression of the exercise duration and intensity.

Supervision and Monitoring

Patient supervision involves both direct patient observation and monitoring of heart rate and rhythm. Blood pressure measurement is generally performed when clinically indicated. The nature and degree of supervision and monitoring depends upon the patient's risk for exercise complications and the intensity of exercise. Supervision and monitoring should be performed most extensively when dealing with high-risk patients (defined above). Patients exercising without medical supervision and monitoring should do so at lower exercise intensities.

Risks of exercise. Major cardiovascular complications during exercise in patients with coronary artery disease are acute myocardial infarction, cardiac arrest, and sudden death. The estimated incidence of cardiovascular complications in supervised cardiac rehabilitation programs are: 1 myocardial infarction per 294,000 patient hours, 1 cardiac arrest per 112,000 patient hours,

and 1 death per 784,000 patient hours (41). Over 80% of patients who have been reported to suffer a cardiac arrest (primarily due to ventricular fibrillation or ventricular tachycardia) in supervised cardiac rehabilitation programs have been successfully resuscitated with prompt defibrillation (41).

CONCLUSION

It is the position of the American College of Sports Medicine that most patients with coronary artery disease should engage in individually designed exercise programs to achieve optimal physical and emotional health. It is recommended that programs include a comprehensive preexercise medical evaluation, including a graded exercise test; and an individualized exercise prescription.

Appropriate exercise programs for patients with coronary artery disease have multiple documented benefits, which can be achieved with a high level of safety. These benefits include enhanced functional capacity; reductions in symptoms of myocardial ischemia, and subsequent coronary artery disease mortality; improvements in blood lipid profiles, weight and hypertension control; and, in diabetic patients, glucose tolerance. In addition, improvements in myocardial perfusion, cigarette smoking cessation, and psychological functioning may also occur.

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