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ABSTRACT

This paper presents information on the effectiveness of exercise programs for heart attack victims. Some of the observations come from unpublished results of a two year experiment of the National Exercise and Heart Disease Project. The paper first establishes that a group exercise program with trained supervision is advantageous for people with heart problems. Then, it discusses the relative advantages of different kinds of exercise stress tests and various drugs, such as glycosides and nitrates, and their effects in conjunction with an exercise program. Training session leaders are warned to make use of direct observation and ECG monitoring in addition to the original tests to see how strenuous an exercise program different individuals should undertake. Specific areas of caution are outlines. Included is a bibliography consisting largely of technical articles on exercise and the heart patient. (CD)

EXERCISE FOLLOWING A HEART ATTACK: SOME SPECIAL CONSIDERATIONS

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Increased physical activity is accepted widely as a means for enhancing cardiovascular function and is being evaluated for the effect on the prognosis of the heart attack victim. Evidence suggests that regular, carefully supervised exercise is both feasible and beneficial for the cardiac (7, 15, 20, 27). In particular, group exercise supervised by well trained highly motivated personnel and in an environment conducive to exercise has favorable results. In our experience, 75% to 80% adherence has been observed for the first year of a multiyear study (unpublished observations), which is considerably better than previous longterm intervention studies (14, 21, 32). A successful program of regular exercise intervention also requires well established principles of physical conditioning. The intent of this paper is to consider the present status of physical conditioning of subjects with arteriosclerotic heart disease with particular emphasis placed upon more recent innovations and ideas. Several of these ideas are based upon unpublished observations from one and one-half years (approximately 4000 subject hrs.) observations of the National Exercise and Heart Disease Project (23).

Exercise Testing

The basis of a physical training program is the exercise stress test. The exercise test follows an appropriate medical history and physical examination, and serves both as a diagnostic tool in identifying coronary artery disease and coronary insufficiency, and for establishing an individual's limits of exercise tolerance. A number of tests have been developed for this purpose (24, 32), each possessing inherent advantages and disadvantages, making the process of test selection sometimes difficult. One must take into consideration such factors as the population being tested, availability of time and equipment, and cost-benefit.

Maximal Testing. Recent evidence indicates that tests of gradually increased workloads to maximal effort (sign or symptom limited) are advantageous over submaximal tests (34). Apparently, maximal testing increases sensitivity in detecting ischemia (8) and is of no greater risk than submaximal testing (28), although there is some question as to whether test specificity (false positives) is enhanced (16). Nevertheless, the best indication of one's tolerance to exercise and the subsequent exercise prescription is determined most accurately with maximal testing. Employing a submaximal end point criteria, or even age predicted maximal heart rate, can result in considerable error in the training heart rate. Since the standard deviation for testing in the prescribed range of 85% to 100% age predicted maximal heart rate is about ± 10 to 15 beats (34), a range of 60 beats is possible in order to include two standard deviations from the mean or 95% of the tested population. The supposed criteria could, in effect, be anywhere from approximately 70% to 100% of the true maximal heart rate, potentially

representing a gross underestimation or overestimation of the true target heart rate.

Intermittent vs Continuous Test Protocol. Whereas there are advantages and disadvantages of both intermittent and continuous testing, the intermittent protocol results in greater aerobic and physical work capacity, reduced central and peripheral metabolic demands at submaximal workloads, and much improved electrocardiograms are possible (12), although test time is increased. Since ECG irregularities are sometimes observed during recovery that were not present in exercise (unpublished observations), abnormal records are more likely to be detected if intervening rest periods are incorporated into the test procedures. If these occurred prior to the end point criteria it would be a signal to terminate the test. With a continuous test protocol such episodes would be missed.

Self Perception of Physical Exertion. Another valuable piece of information can be derived from the individual's objective rating of the subjective level of perceived exertion (5, 25). This score would indicate how strenuous the effort is being perceived, regardless of physiological stress. On the other hand, it is not unusual in cardiacs to observe ischemic signs, ST segment displacement, or marked rhythm alterations that are asymptomatic and at low scores of perceived exertion (unpublished observations). In these instances, relying solely upon the level of perceived effort as the criteria for continuing to exercise would be unsatisfactory.

Pre-Testing. Another consideration in exercise testing is scheduling a pretrial for test familiarization and reducing anxiety. This is important so that heart rate and pain responses are not attributable to

catecholamine increases. Lessening of anxiety and/or learning effect can reduce physiological responses to exercise by 10% (2).

Arm and Leg Testing. If one's usual activity is dominated by arm work functional capacity should be evaluated while exercising with the arms since leg exercise might not provide an accurate assessment of arm capabilities. Compared to exercise with legs at an identical workload, arm work results in higher heart rate, systolic blood pressure, heart rate x systolic blood pressure product, oxygen uptake, minute ventilation and respiratory exchange ratio (11). This indicates increased sympathetic tone when exercising smaller muscle groups. Interestingly, however, prescribing exercise based upon a % maximal heart rate or % maximal oxygen uptake is approximately the same whether using arms or legs (11), or whether the person is a cardiac, normal, or highly trained athlete (17). Apparently, one's oxygen uptake and heart rate, relative to maximum, respond identically to exercise regardless of physical condition.

Pharmacological Agents

Although the prescription of medications is the physician's responsibility, the exercise specialist needs to be familiar with the potential effect of medications upon human performance. In the cardiac rehabilitation program common medications include cardiac glycosides (digitalis, digoxin, lanoxin), nitrates (nitroglycerin, sorbitrate, Isordil, Nitrobid) and beta blocking agents (Inderal, propranolol). Each person's record should indicate clearly if medications are being used. In addition, it is important to determine and record prior to each training session if the prescribed medication was taken and at the appropriate time.

Cardiac Glycosides. Diagnosing ischemia in an individual taking digitalis might be confounded by the ST segment lowering effect of the drug,

thereby increasing the possibility of a false positive diagnosis. Further accentuating the problem is that the resting ECG could be normal whereas physical exertion could cause ST depression. In fact, 50% to 60% of healthy young subjects develop abnormal ST-T wave changes during exercise after digitalization (1, 18, 19). Since ST segment depression during exercise is exaggerated by digitalis in ischemic patients, finding a normal ECG response to effort in a digitalized subject is strong evidence to rule out ischemia (13), although one cannot completely preclude this possibility. In these instances arteriograms would be needed to verify the presence of coronary artery disease.

Nitrates. Nitrates are the preferred medications for treatment of angina pectoris. Their action is to cause blood vessels to dilate, thereby increasing blood supply to the myocardium and decreasing venous return as a result of peripheral vessel dilatation. This results in reduced tension (stretch) in the myocardium, lowered arterial blood pressure, shortened ejection period, and a slight compensatory heart rate increase (13). Typically, the individual who experiences angina pectoris and intervenes with nitrates will have reduced symptoms, be able to increase physical work capacity and adapt better to exercise. The use of nitrates, therefore, can have a marked effect on the exercise prescription. One should also be aware that nitroglycerin, specifically used with acute episodes of angina, can cause a precipitous drop in blood pressure, possibly accompanied by overt side effects, such as light headedness or fainting. Consequently, persons taking nitroglycerin, especially for the first couple of times, should have their blood pressure checked. If it is markedly lower, even if asymptomatic, it is prudent to have such individuals walk about until their blood pressure is somewhat elevated.

Beta Blocking Agents. Beta blocking agents are used to reduce myocardial demands for oxygen by decreasing heart rate, cardiac output, systolic blood pressure and velocity of contraction. These result from impairment of sympathetic stimulation to the heart (13). Compensatory mechanisms associated with these drugs include increase in both stroke volume and arterial-venous oxygen difference.

For those taking beta blockers special consideration must be given to exercise testing and exercise prescription. If the end point of the exercise stress test is a given heart rate, either age predicted maximum or a percent of age predicted maximum, or some predetermined rate, e.g. 150, 170, etc., the intensity of effort will be higher since a greater effort is required to elevate the heart rate. The extent of heart rate reduction with beta blocking agents has been reported to be between 15% and 20% (14).

The individual who begins taking beta blocking agents subsequent to the beginning of an exercise program presents another problem. These persons should be revaluated while on medication since the original target heart rate will now be too high and demand a greater effort relative to maximum capacity. This increases oxygen demands upon the myocardium as well as peripheral muscles, thereby enhancing the possibilities of skeletal-muscular injury.

Some of the more commonly utilized pharmacological agents have been discussed. Knowledge of these drugs and their pharmacological actions is essential for proper interpretation of exercise tests and subsequent exercise training sessions.

Exercise Training

Even though a safe training heart rate has been established on the basis of the exercise test, direct observation and ECG monitoring of actual training sessions is recommended at the beginning of an exercise program. Cardiac responses to work in the environmentally controlled and subdued atmosphere of the testing laboratory can vary considerably from those obtained in the field (Boyer and Kasch, unpublished observations). Our observations have confirmed this on several occasions where marked ECG irregularities were noted during submaximal work which were not apparent during the treadmill test at the same workload taken only a few days earlier (unpublished observations). In addition, ECG monitoring over an extended period of time provides serial data which can reflect subtle changes which are developing slowly. Many of these irregularities are asymptomatic, and would be missed without monitoring.

Warm-up. A thorough warm-up is an important aspect of any training program, but is especially essential for the cardiac. Sudden exertion without warm-up has been associated with increased ischemia as diagnosed from ST segment depression (3, 4). This might be attributed to heart rate increasing more rapidly than myocardial oxygen uptake (11), thereby elevating myocardial oxygen demands disproportionate to oxygen supply.

Arm and Leg Training. One of the principal objectives of cardiac rehabilitation is to improve the quality of life by preparing the person for occupational and leisure time physical activity. Such activities will usually include the musculature of both upper and lower extremities. Consequently, a physical activity program for the cardiac needs to consider exercise for arms as well as legs since training is muscle specific (6, 29, 30, 35). For example, one whose occupational activity

is dominated by arm work will probably not be rehabilitated by virtue of leg training. Therefore, it is necessary to train the arms as well. Several observations have been made of individuals who demonstrate no contraindicating signs or symptoms during high level leg bicycle or treadmill testing, but who experience angina and shoulder discomfort with low level arm work (Herman K. Hellerstein, personal communication).

Training Effect. Considerable documentation supports the beneficial effects of regular exercise upon cardiovascular function in cardiacs (7, 17, 27). Less certain, however, is the dosage required to produce favorable adaptive responses. Exercising at 70% of either age predicted maximal heart rate or the onset of contraindicating signs or symptoms, 3 times a week, 20 - 30 minutes per session, for 6 weeks has been observed to produce favorable gains (unpublished observations). Although alternative methods to % maximal heart rate or % oxygen uptake are available for determining exercise prescription, e.g. caloric cost, fixed heart rates, % of age predicted maximal heart rate (9, 10, 21, 26), it appears that a % of the individual's own maximum is the most accurate. Furthermore, while improvements were observed over a six week period of time from the aforementioned intensity, frequency and duration of training it is well to note that training gains are subject to considerable individual variation. For example, one's level of fitness at the outset affects the rate and amount of change (31). Consequently, those in poorer condition will make greater and more rapid gains at the same level of work and will require less work to elicit the same magnitude of change.

Conclusion

The purpose of this paper has been to present and discuss factors which influence the physical conditioning of cardiacs. The emphasis has

been on new information, often based upon unpublished observations from our two year experience in the National Exercise and Heart Disease Project.

Furthermore, it should be pointed out that the risk of untoward events is kept at a minimum (no major episodes in two years time) with a prudent and well supervised program.

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