TRAINING PROGRAMME FOR PATIENTS OF MYOCARDIAL INFARCTION

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Exercise stress testing has confirmed the clinical observation that patients after acute myocardial infarction (AMI) use the same physiological mechanism to adapt to physical activity as healthy subjects (Chapman and Fraser, 1954)[1], and this led to the hypothesis that these patients would respond to physical conditioning in a manner similar to healthy subjects. In fact, various studies[2,4,5,6,7,8,9,10] carried out throughout the world have shown that a patient after an acute myocardial infarction, who did not return to work because of angina pectoris, psychological reasons or medical misguidance could be returned to work after a short-term of reconditioning programme. It has also been amply demonstrated in several studies that the physical capacity of patients who return to work without reconditioning could be considerably improved if they participated in a supervised physical conditioning programme. The training programme for patients of myocardial infarction presented here is a part of the study carried out under the S.R.S. Research Project.

MATERIAL AND METHOD

164 patients (three months after A.M.I.) were selected for this study. Those with heart failure, hypertension (diastolic over 100 mm.Hg. inspite of treatment), intractable angina, or significant arrhythmia (any arrhythmia becoming worse on ambulation or by mild exercise, equivalent to 2 METS* or whose ergometric test performance was less than 25 Watts/min.) were excluded from this programme. Out of these 164 patients, there were 14 drop outs at various stages of reconditioning and therefore the study of the remaining 150 patients is presented. Their ages ranged from 35 to 60 years with an average of 52 years. All were males.

EXERCISE TEST METHODOLOGY

In 20 patients a bicycle ergometer with mechanical brakes with multistage progressive work loads was used. Calibration for angular displacement was done weekly. In the remaining 130 patients a motor driven treadmill was used.

Before taking up these patients for the reconditioning programme a full clinical and functional evaluation was made.

Conditions of application of effort test were as follows

1. The test was preceeded by a complete clinical cardiovascular examination including a 12 lead E.C.G. in the supine position.
2. Verification of absence of any recent or evolutive cardiopathy.
3. They were supervised by an experienced physician who had efficient means at hand for resuscitation.
4. Radiotelemetric monitoring.
5. Although the ambient temperature should be between 15 and 24 degrees with a relative humidity of less than 80%, this condition could not be always fulfilled.

*MET (METABOLIC EQUIVALENT): This is the energy requirement for basal homeostatis while awake and sitting.

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INTENSITY OF EFFORT TEST

In functional evaluation, subjective symptoms like severe dyspnoea, acute precordial pain, severe giddiness, and intense fatigue were taken as guidelines to stop the effort test immediately. E.C.G. changes requiring discontinuation of the test were paroxysmal arrhythmia, ventricular premature beats either multifocal or those falling in the vulnerable period, conduction disturbances and abnormal ST segment shift. In the absence of signs, symptoms or physiological evidence of intolerance including failure to increase systolic blood pressure, and abnormal E.C.G. changes, the intensity of effort was increased until the heart rate was equal to about 85% for the age group, that is 170 beats per minute for subjects of 20 to 30 years of age, with reduction of 10 beats for each additional 10 years of age (decade).

The duration of effort test in the absence of any indication to stop was 4 minutes with rest for 3 minutes after each stage. If fainting or significant hypotension occurred, the test was repeated on another day to be certain that the result was not spurious. Recovery recordings were made in the sitting position immediately upon cessation of exertion. Follow-up monitored recording was continued for at least 6 minutes, if no abnormal signs or symptoms appeared. If signs and symptoms suggestive of myocardial ischaemia or dysarrhythmia were noted, a longer post exertional recording was carried out till disappearance of the abnormality.

Evaluation of Exercise into Common Denominators

1. The total exercise time per week was approximately 2 hours. The sessions being conducted either 3 times (45 minutes each) or preferably 4 times (30 minutes each).
2. Heart rate was used as the criteria for determining the exercise load. Each patient was encouraged to maintain a heart rate of about 85% of the age adjusted heart rate for at least 50 per cent of the total exercise time.
3. The response level was measured upon entry to the programme and again every 3 months thereafter.
4. Morbidity and Mortality during an average 2 years follow-up was studied.

Parameters Recorded During Effort Exercise

Pulse rate, Blood pressure, and Electrocardiogram were recorded and systolic Time Tension Index was calculated.

Work Loads

With bicycle ergometer the work load was measured in Watts or Kg. per minute. The test was started with a load for warm up of 25 watts (150 Kgm/min.) at speed of 50 revolutions per minute and raised gradually by 25 Watts. The test was discontinued if the patient developed undesirable symptoms, signs or radiotelemetric E.C.G. changes. If the patient could perform a work load equivalent to 7 METS no further load was advised.

With motor driven treadmill warm up is accomplished while walking on the treadmill on a level grade at a speed of 1·0 mph. for 4 minutes. This is followed by a three minute period of rest (recovery). The patient was then made to walk on level grade at a speed of 2·0 mph. Thereafter the workload was increased by elevating the slope of the treadmill bed by 2·5° every three minutes. Each workload approximates an additional increment of the resting metabolic state (MET) i.e. 2,3,4, etc. times the energy cost at rest. The performance at each workload was for 4 minutes to ensure that a steady state was achieved. The test was terminated if the patient developed adverse manifestations or when a work load of 7 METS (i.e. 2 mph on a 17·5% grade; or O_2 equivalent 21·5 ml./kg./min.) was reached.

The patients were reconditioned upto a maximum of 7 METS as their occupations involved on an average a work load of 4 to 5 METS, and in none did it exceed 7 METS.

Patients came for regular follow-up. However, as frequent visits to the rehabilitation centre were inconvenient for quite a few patients, they were prescribed at each stage of the reconditioning programme exercises of equivalent work load to be performed at home or elsewhere.

RESULTS AND DISCUSSION

90 percent of the patients could gradually perform work load of 7 METS. However, in 10 percent of the patients the performance was on an average 5 METS. This could not be increased due to angina, giddiness, increase in heart size or symptoms of cardiac failure, abnormal ST-segment shift or significant arrhythmia. As in all these patients work required energy expenditure of less than 5 METS for their regular jobs, no attempt was made to increase exercise beyond 5 METS, after reconditioning was interrupted due to undesirable response.

The results were assessed after reconditioning with the help of the following data:

1. Heart rate and systolic blood pressure at rest and while performing at comparable levels of work loads.
2. Physical working capacity.
3. Systolic Time Tension Index at submaximal (85%) work levels.
4. Improvement in E.C.G.
5. Subjective improvement
6. Behavioural, Social and sexual adjustment
7. Return to work (to study morbidity)
8. Mortality.

(1) Heart Rate

The average resting heart rate before reconditioning was 75/minute. After 3 months of reconditioning, the heart rate dropped to 70/minute and after 10 months to 68/min. Before reconditioning, the average heart rates for work loads of 3 METS and 5 METS were 105/min. and 124/min. respectively. These figures dropped to 90/min. and 105/min. respectively after 3 months of reconditioning and to 86/min. and 100/min. respectively after 10 months on the reconditioning programme. These figures were slightly higher in the 10 percent patients who had interruptions due to symptoms and signs but the difference was not satistically significant mainly because of the small number in this group.

(2) Systemic Blood Pressure

Systolic blood pressure rose on an average by 12 mm. Hg. per MET of workload before reconditioning. This figure dropped to 9 mm. after 3 months and to 8 mm. after 10 months of reconditioning programme. The diastolic blood pressure was found to decrease on an average by 2 mm. and 3 mm. per MET after reconditioning for 3 and 10 months respectively. Before reconditioning, there was negligible change in the diastolic B.P. after exercise. However, in 10 patients the diastolic blood pressure tended to rise abnormally i.e. more than 10 mm.Hg.) after exercise. These were hypertensive prior to the attack of myocardial infarction and had to be given anti-hypertensive drugs which successfully prevented this abnormal diastolic blood pressure response.

(3) Physical Working Capacity

The mean normal physical working capacity of healthy adult males is based on a mean body surface of 1·75 sq. meters and the submaximal values are 150 $\pm$ 10·3 watts for men, 18 to 39 years; 125 $\pm$ 10·7 watts for men 51 to 60 years old. Our figures for healthy individuals are comparable to these figures when corrected for body area. The average P.W.C. before reconditioning was found to be 60 percent of the normal expected P.W.C. of healthy matched controls. After 3 months and 10 months of reconditioning this increased to 68% and 73% respectively. The P.W.C. before reconditioning as well as the increase after reconditioning is lower as compared to that reported by other authors[3,4,5] who have reported an increase of P.W.C. to as much as 85% of the normal healthy individuals. Even if the best reported figures are considered, it can be seen that the P.W.C. in patients of myocardial infarction even after reconditioning remains considerably less than that of matched healthy controls. The increased P.W.C. has been reported to drop down if patients stop their exercises. In our series this part was not studied.

(4) Systolic Time Tension Index (STTI)

STTI was calculated at submaximal (85%) work levels. This parameter represents the product of the systolic arterial blood pressure and heart rate. Hellerstein (1968)[3] feels that the STTI adequately reflects the myocardial work related to exercise.

It has been established that its value is consistently higher in the cardiac patients than in healthy subjects at comparable work loads. For the same work load STTI decreased on an average by 15% after 3 months of reconditioning and slightly more after 10 months of reconditioning.

(5) Improvement in E.C.G.

E.C.G. monitoring detects abnormal response like ischaemic ST changes, appearance of conduction defects or arrhythmia etc. Exercise is discontinued if abnormal response appears. However, after reconditioning in a majority of the patients some improvement in resting E.C.G. was noted and so also disappearance of abnormal response which occurred initially in some patients. However, in a minority (8%) after the exercise load increased beyond 5 METS, angina as well as ST-T changes appeared and necessitated prevention of further increase of work load. Although exercise E.C.G. showed abnormal response after 5 METS in these patients, the resting E.C.G. had not deteriorated—but often did not improve.

(6) Subjective Improvement

Except 8% patients who complained of angina and 2% patients who complained of symptoms suggesting heart failure after the exercise load exceeded 5 METS, the remaining majority uniformly felt very much better. Their self-confidence improved and most expressed a sense of well being—a 'joy de verve'.

(7) Behavioural, Social and Sexual adjustment was found to have considerably improved after reconditioning. The patients modified their total style of life even though physical exercise was the only additional therapeutic factor. Naughton *et al* (1968)[6] have similar observations. Sexual adjustment was much better as was evident by lack of fear and absence of impotence in the reconditioned patients. After acute myocardial infarction, some patients are known to withdraw from sexual activity because of fear of dying. Impotence is another complication which may occur in post-infarct patients. Improved self-confidence and lack of absenteeism from place of work helped in better social adjustment. Although the life style changed for the better, the psychological make up remained unchanged.

(8) Return to Work (Morbidity)

92% of patients returned to work within three months of reconditioning—70% to their original work while the rest on modified jobs. At the end of 10 months all except 10 percent went back to their original work. The 10 percent who either developed angina pectoris, or showed signs of cardiac enlargement or cardiac failure were advised modification in their job and were still on modified jobs at the end of the follow-up period of 2 years specially those whose work involved work load over 5 METS and in whom drastic modifications had to be made.

(9) Mortality

Only 5 patients died during an average follow-up period of 2 years which makes it less than 3 per cent in 2 years. The mortality rate in reconditioned patients is much lower than that reported in other studies. These patients were a selected group from a total of 300 patients screened before they were taken in the reconditioning programme. Even so, such a low mortality rate is very encouraging.

Kellerman (1972)[4] reported mortality of 5·7% in his patients reconditioned for a period of 24 to 54 months. Mortality in the study of Naughton *et al* (1972) was also low.

SUMMARY

150 patients were chosen for the reconditioning programme three months after acute myocardial infarction. The programme consisted of graded exercises and was monitored at each stage by symptoms, signs and a radiotelemeter. 90 per cent of the patients could reach the work load of 7 METS aimed at and continued it without adverse effects. However, 10% could only perform upto 5 METS due to undesirable problems. As in most of these patients the work load required for their job was less than 5 METS, no attempt was made in these to cross the 5 METS limit.

The patients benefitted from the reconditioning programme in the following manner:

(a) Heart rate levels at rest and while performing at comparable levels of work load decreased significantly.

(b) Systolic blood pressure levels at rest and while performing at comparable levels or work load decreased significantly; the former on an average by 15 mm.Hg.

(c) Systolic Tension Time Index for submaximal work loads decreased by 15% after reconditioning.

(d) Physical working capacity increased considerably after reconditioning but did not reach the levels equal to that of normal individuals.

(e) There was subjective improvement and better behavioural, social and sexual adjustment.

(f) In the reconditioned patients morbidity as well as mortality in a follow-up period averaging two years was very low.

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