Scintigraphic Evidence of Improvement in Myocardial Perfusion Associated with Improvement in Physical Fitness in a patient with Angina

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SUMMARY: A young soldier with a small myocardial infarction and a large area of ischaemic myocardium was followed up by maximal exercise testing and thallium scanning during a 15 month period of cardiac rehabilitation which included strenuous physical exercise. The area of ischemic myocardium was seen to reduce markedly over this period as measured by thallium scanning. Such clearly evident changes have not so far been reported in these circumstances.

Introduction

While physical training appears to improve angina pectoris by increasing exercise tolerance¹ and morale^{2, 3} and by reducing the amount of ST segment depression on the exercise electrocardiogram⁴ it is not yet clear whether this is accompanied by an improvement in myocardial perfusion in the ischemic area. We have followed the course of a young soldier with angina pectoris by means of maximal exercise testing and thallium (²⁰¹Tl) scanning and present evidence that the area of myocardium at risk has greatly diminished following improvement in physical fitness.

Case Report

The patient, a 35 year old cook, was admitted as an emergency with burning chest pain in a band across his chest, associated with tingling in the left arm which had come on at rest and lasted several hours. He had similar but milder pains for three weeks prior to admission which came on predictably while rushing uphill, but never at other times, and was relieved within 10 minutes by resting. The initial electrocardiogram (ECG) showed T wave inversion in standard lead I, and in lead V3. Over the next two weeks the T wave normalised in standard lead I but remained unchanged in lead V3. Lactic dehydrogenase estimations on days one to three were 230, 250 and 141 units respectively (normal range 36-188 units). On maximal exercise testing three weeks later the patient reached a maximal heart rate of 180 beats per minute, nine minutes into the Bruce protocol⁵ (stage III). The systolic blood pressure rose to 190 mm Hg.

Chest pain began at four minutes and was gone

by 18 minutes, but the ECG did not change. Thallium scan carried out within 10 minutes of exercise and again four hours later showed an extensive and reversible filling defect in the septum (fig 1). Three months later a further maximal exercise and thallium scan was carried out. In the interim the patient had been given instructions to increase his activity to the onset of pain, and reported that he was now performing three half-hour sessions per week of circuit training in the gymnasium and was walking eight miles every day. He was also jogging intermittently. This time he exercised to 10 minutes of the Bruce protocol (stage IV) and reached a heart rate of 190 beats per minute, and a maximum systolic blood pressure of 180 mm Hg. Chest pain began in the fifth minute and lessened as the test went on, to disappear by the fourteenth minute. Thallium scan showed a marked diminution of the ischemic area (fig 2). Six months later he underwent cardiac catheterisation having been admitted twice in the interim with transient chest pain and palpitations without further abnormality being detected. Cardiac catheterisation showed total occlusion of the anterior descending branch of the left coronary artery distal to a large first diagonal and small first septal branch. Cross filling from the right coronary artery was noted. There was some dilation of the left ventricle (end-diastolic volume index 110 mls/M²) and apical hypokinesia but the ejection fraction remained good at 0.67. Several months later, almost a year after his initial admission, the patient underwent a three week in-patient course of cardiac rehabilitation which included three 20 minute exercise sessions daily to a heart rate 80% of that reached on maximal exercise testing. Finally, 15

ANTERIOR 18.12.79 **LAO 45 18.12.79** **Fig. 1a. Exercise Views****ANTERIOR 18.12.79** **LAO 45 18.12.79** **Fig. 1b Delayed Views**

months after his initial event, he again underwent maximal exercise testing and thallium scanning. This time he exercised for 10 minutes to stage IV of the Bruce protocol and reached a heart rate of 190 beats per minute, and a maximum systolic blood pressure of 180 mmHg. Chest pain was present for 30 seconds in the seventh minute only, and again the ECG did not change. Thallium scan this time showed only a small defect at the apex (fig 3).

Discussion

The initial presentation of the patient suggested a small myocardial infarction or episode of coronary

artery spasm. The ECG and enzyme findings, and later the left ventricular angiogram, were compatible. The angiographic findings in the coronary arteries suggested the patient had a slowly occluding major stenosis of the anterior descending branch of the left coronary artery. The event he suffered may have been the moment of complete occlusion or an embolic phenomenon. The anterior views of the three resting thallium scans suggest permanent underperfusion of the apex and are compatible with a small infarct in that area. Three weeks after the event the patient had a large reversible defect in the interventricular septum and had compatible

Fig. 2a Exercise Views

Fig. 2b Delayed Views

symptoms. Over the next 15 months that area markedly reduced, as did the symptoms. This in itself is an important phenomenon and, to our knowledge, has never before been so clearly demonstrated. The fact that the period of improvement coincided with a change in lifestyle which included a marked increase in physical fitness in no way proves that the improvement was the result of exercise. Nevertheless, this association has been clearly shown in animal experiments^{6, 7, 8}. There have been many attempts to investigate the phenomenon of improvement in angina with improvement in physical fitness. Most of these have concluded that peripheral factors, such as reduction of pulse rate and blood pressure for a given work load⁹⁻¹¹, and increased mitochondrial efficiency in the peripheral muscles¹² are responsible. Nevertheless, there have

been findings that the ratio of myocardial capillary to fibre ratio is increased¹³, that the bore of the coronary arteries is increased¹⁴, and other supporting evidence⁴. Froelicher et al¹⁵ presented 5 cases with coronary artery disease in which a programme of strenuous physical exercise appeared to reduce the area of ischemic myocardium but only one of these cases was reputed to have angina pectoris and in any case the changes were described by the authors as "subtle."

We have shown that marked reduction in the area of myocardium at risk in angina pectoris can occur. That this reduction occurred in relation to strenuous physical exercise is an indication that the improvement in angina consequent on improved physical fitness may not be a peripheral phenomenon entirely.

ANTERIOR 4.3.81

MARLOW, DENH EXERCIS, HEART, S, 4-3-81
SAVE AREA 1
XANTH: 1
XANTH: 1

LAO 45 4.3.81

MARLOW, DENH EXERCIS, HEART, S, 4-3-81
SAVE AREA 1
XANTH: 1
XANTH: 1

Fig. 3a Exercise Views

ANTERIOR 4.3.81

MARLOW, DELAYED, HEART, S, 4-3-81
SAVE AREA 1
XANTH: 1
XANTH: 1

LAO 45 4.3.81

MARLOW, DELAYED, HEART, S, 4-3-81
SAVE AREA 1
XANTH: 1
XANTH: 1

Fig. 3b Delayed Views

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