SCIENTIFIC LETTER

Is early, low level, short term exercise cardiac rehabilitation following coronary bypass surgery beneficial? A randomised controlled trial

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Through the relief of myocardial ischaemia, the goal of coronary artery bypass grafting (CABG) is to preserve and if possible to restore cardiac function towards normality. Evaluation of cardiovascular haemodynamics has enhanced our understanding of functional disability in cardiac patients, and provided prognostic classification.[1] It is therefore important to investigate whether exercise rehabilitation following CABG is able to confer further improvements in cardiac performance as well as increasing functional capacity. Exercise rehabilitation has been reported to improve the prognosis,[2] exercise capacity, and cardiac performance of patients with coronary artery disease. The levels of cardiac rehabilitation service provision within the UK are very varied.[3] We have therefore investigated whether a representative hospital based supervised cardiac rehabilitation programme providing early, low level, and short term exercise training can improve the cardiac and physical functional status of patients post-CABG.

METHODS

We interviewed 100 patients who were on the waiting list for CABG and found that only 22 of them expressed no preference either for or against exercise rehabilitation following their surgery. They performed a familiarising cardiopulmonary exercise test. Six weeks postoperatively the patients were randomised either to attend the hospital based exercise rehabilitation programme or supervise their own recovery. Those in the rehabilitation group attended once a week for six weeks. On each occasion they completed 12 aerobic exercise stations specifically designed to incorporate the use of different skeletal muscle groups. Each week the level of exercise was increased to incorporate more repetitions or a greater workload. The patients performed a maximal cardiopulmonary exercise test as previously described,[1] one week before and one week after rehabilitation. The supervisors of these tests were blinded to the patient grouping. Those in the control group were tested on an identical time scale. Ethical approval and informed consents were obtained. Data from before and after the study period were compared using the Student's *t* test for paired samples. A probability value of $p < 0.05$ was considered significant.

RESULTS

The two study groups were similar in size and demographic characteristics. All patients participating in the study completed the protocol. There were no deaths or major cardiac events. There was 90% attendance at rehabilitation sessions. Exercise test data are shown in table 1. At baseline both groups demonstrated similar resting and exercise cardiopulmonary responses. Following the six week study period, neither group showed any significant changes in resting parameters. During exercise the mean (SD) rate of ventilation/rate of oxygen uptake ($\dot{V}E/\dot{V}O_2$) at 1 litre/min of $\dot{V}O_2$, and the rate of ventilation/rate of carbon dioxide uptake ($\dot{V}E/\dot{V}CO_2$) at 1 litre/min of $\dot{V}CO_2$, decreased significantly in the rehabilitation group (28 (5) *v* 26 (4) l/min and 33 (5) *v* 31 (4) l/min, respectively, both $p < 0.05$), but remained essentially unchanged in the controls. There were significant increases in peak cardiac output (CO, 11.3 (2.2) *v* 12.2 (1.7) l/min, $p < 0.05$), peak cardiac power output (CPO, 2.97 (0.84) *v* 3.31 (0.7) W, $p < 0.05$), and the overall cardiac reserve (1.92 (0.72) *v* 2.19 (0.53) W, $p < 0.05$) in those who underwent formal rehabilitation. The increases in the control group did not reach significance. When comparing the magnitude of changes between the groups, the increases were greater in the rehabilitation group in all parameters, with the increment in peak CPO achieving significance (0.34 (0.47) *v* 0.035 (0.21) W, $p < 0.05$). Exercise time and peak $\dot{V}O_2$ increased significantly in the rehabilitation group (11.2 (3.6) *v* 13.2 (3.1) mins, $p < 0.0001$, and 20.5 (4.6) *v* 22.3 (3.4) ml/kg/min, $p < 0.005$) and also in the control group (10.8 (4.9) *v* 12.3 (4.7) mins and 20.4 (6.4) *v* 22.7 (6.9) ml/kg/min, respectively, all $p < 0.005$).

DISCUSSION

In this study we found that low intensity supervised exercise training early postoperatively, typically provided in a UK National Health Service hospital, in a cohort of patients who expressed no preference for or against rehabilitation, did not improve exercise capacity beyond that achieved by the corresponding controls. Nevertheless, the same low level early exercise rehabilitation had already shown improvements in indices of cardiac and pulmonary function. Whether these cardiopulmonary improvements will subsequently produce greater exercise capacity with extended exercise programme would require a further study.

Our results contrast with those of the only other randomised, controlled study of a post-CABG population, in which the trained group achieved a significant increase in peak $\dot{V}O_2$ and a decrease in submaximal heart rate.[4] The training sessions were more intense (85% of peak $\dot{V}O_2$), more frequent (three times a week), and continued for one year as opposed to six weeks. One limitation of this study was that the results could have arisen because the study was designed to recruit only those individuals highly motivated to exercise.

Our results also contrast with those of other studies which show that exercise training leads to a significant improvement in exertional capacity and cardiac function in patients with ischaemic heart disease.[5] The training necessary to achieve such improvements was either more frequent (for example, every day), more prolonged (for example, one year), or both,

Abbreviations: CABG, coronary artery bypass graft; CO, cardiac output; CPO, cardiac power output; $\dot{V}CO_2$, rate of carbon dioxide production; $\dot{V}E$, rate of ventilation; $\dot{V}O_2$, rate of oxygen uptake

Table 1 Cardiopulmonary and haemodynamic variables, before and after the study period

	Rehabilitation group		Controls	
	Baseline	6 weeks	Baseline	6 weeks
Exercise time (minutes)	11.2 (3.6)	13.2 (3.1)†	10.8 (4.9)	12.3 (4.7)†
Peak $\dot{V}O_2$ (ml/kg/min)	20.5 (4.6)	22.3 (3.4)†	20.4 (6.4)	22.7 (6.9)†
Anaerobic threshold (ml/min)	1240 (244)	1297 (236)	1172 (328)	1263 (388)
RER	1.09 (0.08)	1.15 (0.1)	1.09 (0.13)	1.08 (0.12)
Rest heart rate (beats/min)	86 (15)	87 (12)	90 (17)	84 (12)
Peak heart rate (beats/min)	141 (19)	147 (18)	145 (23)	144 (23)
Rest mean blood pressure (mm Hg)	103 (14)	104 (14)	98 (12)	99 (8)
Peak mean blood pressure (mm Hg)	119 (14)	122 (12)	118 (8)	115 (10)
$\dot{V}E/\dot{V}O_2$ at 1litre $\dot{V}O_2$ (l/min)	28 (5)	26 (4)*	27 (3)	26 (4)
$\dot{V}E/\dot{V}CO_2$ at 1 litre $\dot{V}CO_2$ (l/min)	33 (5)	31 (4)*	32 (2)	31 (3)
Rest CO (l/min)	4.59 (1.09)	4.83 (1.29)	4.19 (0.91)	4.19 (0.8)
Peak CO (l/min)	11.3 (2.2)	12.2 (1.7)*	11.9 (3.1)	12.2 (2.8)
Rest CPO (W)	1.05 (0.31)	1.12 (0.37)	0.92 (0.22)	0.95 (0.23)
Peak CPO (W)	2.97 (0.84)	3.31 (0.7)*	3.04 (0.83)	3.1 (0.84)
Cardiac reserve (W)	1.92 (0.72)	2.19 (0.53)*	2.12 (0.78)	2.16 (0.71)

Results are expressed as mean (SD).
*$p<0.05$, †$p<0.005$, at 6 weeks versus baseline.
CO, cardiac output; CPO, cardiac power output; RER, respiratory exchange ratio; $\dot{V}CO_2$, rate of carbon dioxide production; $\dot{V}E$, rate of ventilation; $\dot{V}O_2$, rate of oxygen uptake.

than in our study. Even those studies assessing "low intensity" training required patient attendance at least three times a week for two to three months.[6] Hitherto, it has been unclear whether the provision of low level exercise training was of any benefit to patients. This study has shown that in terms of benefits in exercise capacity, such low levels are indeed insufficient, but it also showed that even at this low level of provision, structured exercise training produced objective benefits in terms of cardiac and respiratory function. There is therefore a need to conduct a dose–response study to ascertain what levels of exercise training are minimal and optimal to provide functional benefits.

The findings in this study suggest that the provision of cardiac rehabilitation post-CABG in many UK centres may be insufficient and needs to include more frequent exercise training sessions over a sustained period. Taking our results in conjunction with other studies, there is now overwhelming evidence of the beneficial effects of exercise training on functional capacity and cardiopulmonary function in patients with ischaemic heart disease, provided an adequate service is available.

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REFERENCES

1 **Williams SG**, Cooke GA, Wright DJ, *et al.* Peak exercise cardiac power output: a direct indicator of cardiac function strongly predictive of prognosis in chronic heart failure. *Eur Heart J* 2001;**22**:1496–503.
2 **O'Connor GT**, Buring JE, Yusuf S, *et al.* An overview of randomised trials of rehabilitation with exercise after myocardial infarction. *Circulation* 1989;**80**:234–44.
3 **Horgan J**, Bethell H, Carson P, *et al.* A working party report on cardiac rehabilitation. *Br Heart J* 1992; **67**:412–8.
4 **Froelicher V**, Jensen D, Sullivan M. A randomized trial of the effects of exercise training after coronary artery bypass surgery. *Arch Int Med* 1985;**145**:689–92.
5 **Goble AJ**, Hare DL, Macdonald PS, *et al.* Effect of early programs of high and low intensity exercise on physical performance after transmural acute myocardial infarction. *Br Heart J* 1991;**65**:126–31.
6 **Belardinelli R**, Georgiou D, Scocco V, *et al.* Low intensity exercise training in patients with chronic heart failure. *J Am Coll Cardiol* 1995; **26**:975–82.