Case Report

High Intensity Exercise Training Programme Following Cardiac Transplant

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ABSTRACT

A 26-year-old male patient who presented with symptoms of end stage cardiac failure as a result of dilated cardiomyopathy, had an orthotopic cardiac transplantation. A comprehensive cardiac rehabilitation programme was provided to him and he was introduced to a sport (tennis). The exercise training programme progressed from low intensity training to high intensity programme over a period of 15 months. A cardio-pulmonary exercise test done 22 months after surgery suggested that he was able to achieve the aerobic capacity comparable to that of a normal South Indian subject. He participated successfully in the World Transplant Games in Sydney and returned safely. This suggests that after a proper cardiac rehabilitation programme, patients undergoing heart transplantation can achieve normal physiological responses to lead a normal active life. **[Indian J Chest Dis Allied Sci 2006; 48: 271-273]**

Key words: Cardio-pulmonary exercise testing, Cardiac transplantation, Cardiac rehabilitation.

INTRODUCTION

Orthotopic heart transplantation is an established therapeutic procedure for end stage heart failure patients[1]. The haemodynamic responses following transplant during exercise in the supine and in the upright posture have been well documented[2,3]. In general, less than normal increase in cardiac output at more than normal ventricular filling pressures is noted during exercise in a transplant recipient. These observations have been attributed among many reasons, mainly to the effects of cardiac denervation, a mismatch of donor and recipient cardiac size, myocardial fibrosis resulting from rejection and graft vascular disease[4,5]. The beneficial effects of exercise training programme for transplant recipients are well known[6,7].

CASE REPORT

A 26-year-old male patient, who presented at our Institute of Cardio-vascular Diseases, Chennai, with end stage cardiac failure as a result of dilated cardiomyopathy, underwent orthotopic cardiac transplantation on 5th December 1995. The post-operative course was uneventful, leading to a complete recovery. Regular follow up including endomyocardial biopsies, coronary angiograms, 2D echocardiograms and clinical assessments were done periodically to assess rejection episodes and improvement in his physical endurance according to the protocol[8]. His aptitude to learn tennis and his zeal to participate in World Transplant Games (WTG), Sydney, Australia were identified and encouraged. A comprehensive rehabilitation programme[9] was offered to him to re-develop his exercise tolerance. After six months of transplantation, he was constantly motivated to ensure compliance and was guided through the exercise programme, which progressed from a low intensity training to a high intensity training programme for a period of 15 months. At the beginning of the exercise programme, patient had dyspnea (class II), no evidence of clinical congestive cardiac failure, normal chamber dimensions and normal ejection fraction by 2D echocardiogram. Towards the end of this training programme, his rating of perceived exertion was in the range of 16-17[10]. One week before his departure to participate in WTG, a graded exercise test was done in September 1997 in the Cardio-pulmonary Medicine Unit of the Tuberculosis Research Centre (ICMR) using a motorised treadmill and with a metabolic cart which analysed respiratory gases (Morgan, Chatham, UK). The Bruce protocol was used for the exercise testing[11, 12]. Analyzers were calibrated with gases of known concentrations before each session. The participants

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breathed through a mouth piece and wore nose clips throughout. Expired gas collection was performed with a low resistance, small dead space Rudolph valve. Ventilatory parameters were measured with an intake turbine ventilometer. Expired O_2 content was determined with a model QA 500 paramagnetic analyzer and carbon dioxide content was measured by a model 901 infrared CO_2 analyzer (PK Morgan Instruments Inc.). Data were supplied to a Magna 88 computer, which provided 15-second averages of oxygen consumption, minute ventilation, tidal volume, respiratory rate, respiratory exchange ratio and ventilatory equivalent for oxygen and carbon dioxide. Heart rate and arterial oxygen saturation were measured by a pulse oximeter (Ohmeda model IV A) continuously during the exercise test. Data were initially obtained for three minutes at rest. Maximal exercise effort was defined by fatigue, facial flushing, dyspnoea and unsteady gait in conjunction with respiratory exchange ratio over 1.0 or achieving maximal heart rate (% predicted $\pm$ 5%). Maximal oxygen consumption and ventilatory parameters were taken as the highest achieved during exercise. Basic gas and flow measurements were corrected for ambient temperature, barometric pressure and water vapour. Anaerobic threshold was defined as $\dot{V}O_2$ at which expired carbon dioxide increased non-linearly relative to oxygen consumption (v-slope).

Table. Cardio-pulmonary exercise test parameters

Parameters	Patient	Control	% of Control
(a) *Metabolic Parameters*			
1. $\dot{V}O_2$ (ml/min)			
Rest	335	380	88
Maximal Exercise	1600	2300	70
2. $\dot{V}O_2$/kg (ml/min/kg)			
Rest	5.2	5.9	88
Maximal Exercise	24.6	35.9	69
3. $\dot{V}O_2$ at AT (ml/min)	1320	1935	-
(% of $\dot{V}O_2$ max)	(82.5%)	(84%)	-
(b) Gas Exchange Parameters			
1. $\dot{V}E/\dot{V}O_2$ (ml/min)			
Rest	33.8	32.4	104
Maximal Exercise	41.3	38.7	107
2. $\dot{V}E/\dot{V}CO_2$ (ml/min)			
Rest	31.5	32.4	97
Maximal Exercise	30.2	32.7	92
3. Respiratory Exchange Ratio			
Rest	0.9	0.9	100
Maximal Exercise	1.4	1.2	117
(c) Ventilatory Parameters			
1. Respiratory Rate (/min)			
Rest	21	19	111
Maximal Exercise	44	44	100
2. Tidal Volume (ml)			
Rest	546	634	86
Maximal Exercise	1457	2374	61
3. Ventilation (L/min)			
Rest	11.4	12.3	93
Maximal Exercise	71.5	90.7	79
(d) Cardiovascular Parameters			
1. Pulse (beats/min)			
Rest	100	75	133
Maximal Exercise	172	184	93
2. O_2–Pulse (ml/min)			
Rest	3.4	5.1	67
Maximal Exercise	9.3	12.5	74
3. O_2 Saturation (%)			
Rest	96	98	98
Maximal Exercise	97	97	100

$\dot{V}O_2$=Oxygen consumption; AT=Anaerobic threshold;
$\dot{V}E/\dot{V}O_2$=Ventilatory equivalent for oxygen;
$\dot{V}E/\dot{V}CO_2$=Ventilatory equivalent for carbon dioxide.

On treadmill, our subject could perform Bruce stage IV attaining appropriate blood pressure response. Patient could attain 70% of control $\dot{V}O_2$ max and 93% of maximal control heart rate. There were no arrhythmias and ST-T changes. The cause of termination of test was fatigue. Cardio-pulmonary exercise data compared with age- and sex-matched control South Indian subjects are given in table. The data suggest that, if a properly structured Comprehensive Rehabilitation Programme is offered to a cardiac transplant patient, he can achieve the aerobic capacity of a normal person, and this has helped our patient to participate in an enduring sport competition like lawn tennis at WTG held at Sydney, Australia in 1997. He successfully participated in the WTG and returned safely. The last follow up in January 2004 revealed that his physical endurance is maintained and he achieved 10 metabolic equivalents (METs) on treadmill test by Bruce Protocol and one metabolic equivalent is equal to 3.5 ml O_2/kg/min.

DISCUSSION

The denervated donor heart has a higher resting heart rate and smaller resting stoke volume[13]. The peak heart rate achieved during exercise is lower. Inappropriate response to circulating catecholamine leads to reduced stroke volume during exercise and thereby, limiting the exercise tolerance[14]. Another potential cause is altered muscle metabolism secondary to immunosuppressive therapy[15]. Cyclosporine A, the common immunosuppressive agent used to treat post transplant patients has been shown to affect muscle metabolism. Cyclosporine A significantly reduces muscle mitochondrial respiration and therefore result in sub maximal exercise endurance[15]. Lean tissue loss following major surgery is common and is exacerbated by steroid administration. This is also the result of prolonged, preoperative physical inactivity due to cardiac illness. This reduction in muscle mass plays a major role in limiting maximum exercise performance. Because of low peak oxygen uptake, exercise is quickly halted by fatigue. Anxiety and postoperative debility can also significantly limit exercise tolerance. Several studies have shown that a constructive rehabilitation programme involving multidisciplinary efforts would

enable the heart transplant recipients to improve exercise tolerance significantly[16-18].

Our subject was able to achieve normal physiological responses to exercise after the cardiac transplantation. This was possible by the right motivation and the excellent cardiac rehabilitation programme provided to the patient. This emphasizes that individuals with end stage cardiac failure who had undergone successful cardiac transplant and had appropriate and sustained cardiac rehabilitation can lead a normal active life. We believe that our case is the first report of an Indian Cardiac Transplant recipient undergoing supervised high intensity exercise programme to achieve normal physical endurance. The fact that he was able to achieve 10 METs on treadmill test by Bruce Protocol eight years after the transplantation was an indication that he was maintaining his physical endurance at least eight years following the transplant.

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