

Exercise capacity following heart transplant: case report on the physical work capacity of a 37 year old competitive cyclist following orthotopic heart transplant

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Abstract. Physical work capacity in heart transplant recipients typically does not exceed 60% of age-predicted normal levels. It is unknown what levels might be achieved in these patients if they were involved in strenuous exercise training prior to transplantation. A 37 year-old, professionally trained male cyclist suffered an acute myocardial infarction immediately following a road race and received a heart transplant four months later. The participant resumed training for competitive cycling one month following the transplant. His peak VO₂ was 92% and peak heart rate was 90% of age predicted values six months post transplant. Results indicate that for this participant, a more aggressive approach to heart transplant recovery was well tolerated and suggests that similar programs could be applied to other heart transplant recipients.

1. Introduction

The great majority of heart transplant recipients (HTRs), because of end-stage heart failure, experience a slow decline in physical work capacity (PWC; Watts and/or peak oxygen uptake, VO₂peak Ml•kg⁻¹•min⁻¹) prior to surgery (i.e., < 60% peak-predicted VO₂peak).[1] Studies comparing PWC before and soon after transplantation (~2 months) have shown significant (+ ~ 30% of pre-transplant value) spontaneous recovery of PWC.[1] However, post-transplantation PWC of HTRs normally does not exceed 60% of the value for healthy age-match controls.[2]

This paper presents the case of a 37 year-old, professionally trained cyclist who suffered a cardiovascular event immediately following a road race of 52 miles and ultimately received a heart transplant four months following the event. Two months prior to the cardiovascular event the participant completed a PWC evaluation. The participant resumed training one month following surgery and underwent an exercise

stress test six months post surgery. The focus of this report is threefold: 1) comparison of PWC prior to acute myocardial infarction (AMI) to PWC following heart transplant; 2) level of PWC following surgery in comparison to age-matched HTR peers; and 3) ability/limitations to resume training and frequency and intensity of that training.

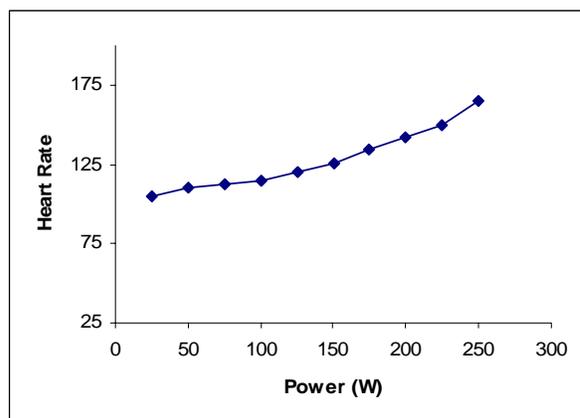
2. Results, Discussion

At the time of the post-transplant PWC evaluation, neither left ventricular dysfunction (i.e., cardiac allograft vasculopathy, oxidative stress, and/or activation of various allo-antigen-dependent and – independent factors caused by cytokine release) nor lung limitations (i.e., diffusion abnormalities) had been detected by his medical team. This suggests, for the participant in this report, that chronotropic incompetence (i.e., central) and muscle limitations (i.e., peripheral) would remain as the major limitations to his PWC following transplantation.

The participant underwent an orthotopic heart transplant resulting in complete denervation of his heart. The loss in autonomic innervation of the SA node has been reported to reduce peak heart rate (HR) response, during an incremental exercise test to voluntary exhaustion, by 30-40% than that of age-matched controls.[2]

Studies examining responses to progressive exercise in HTR suggest that peak HR is significantly higher in healthy controls compared to HTR (~66% of predicted) and that PWC is related to HR at peak exercise.[3] Interestingly, results of the post-transplant exercise test show that the participant has a good relationship

Figure 1. Heart rate response to work load. Units for heart rate are beats per minute and units for power are Watts.



between HR and the increasing workload (Figure 1). In addition, his maximal HR achieved (165 b/min) was 90% of his maximal HR (183 b/min) achieved during the performance test approximately one year prior to the cardiac event.

In a comparative study, Richard and colleagues (1999) measured PWC in 14 endurance trained orthotopic HTRs.[4] Peak exercise responses for the participant in the present study and in those reported by Richard et al. (1999) were similar for peak heart rate (165 bpm vs. 159 ± 16 bpm) and VO_{2peak} ($33.8 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ vs. $32.5 \pm 7.8 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$), respectively. In addition, those participants had been training regularly for 36 ± 24 months prior to testing and PWC evaluations occurred 43 ± 12 months following heart transplant (HT). In comparison, the participant in this study had been cleared from all training restrictions three months prior to PWC evaluation which took place 6 months following HT.

Muscle atrophy and deconditioning are another characteristic which limits PWC in patients immediately following HT.[5] In this study, the measured VO_{2max} did not seem to be limited by the participant's muscular endurance. Although the participant achieved 92% of his predicted VO_{2max} , the exercise data indicates that his ventilatory capacity was limited. VE (133.32 L/min) and ventilatory equivalents for oxygen (VE/ VO_2) and carbon dioxide (VE/ VCO_2) showed higher ratios due to inferior lung function and RER values increased rapidly (Table 1). This may suggest that the participant's peak exercise capacity was limited by cardiopulmonary factors (i.e., central) rather than muscular endurance (peripheral).

This ventilatory limitation is similarly found in lung transplant recipients where the adaptation of the respiratory system is slower to catch up to the cardiovascular system.[6] This suggests that the

deconditioning that occurred in the pulmonary system

Table 1. Cardiopulmonary Exercise Test results 6 months post transplant

	Resting	Max Achieved	Predicted	% Predicted
VO_{2max} ($\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$)	15.1	33.8	36.7	92.2
VO_2 ($\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$)	1479	3316	3606	92
RER	0.95	1.18		
VE (l/min)	42.87	133.32		
VE/ VO_2 (L/L)		41.08		
VE/ VCO_2 (L/L)		34.73		
Freq ($\text{br}\cdot\text{min}^{-1}$)	26	63		
VT ($\text{ml}\cdot\text{min}^{-1}$)	1666	2899		
HR (bpm)	115	165	183*	90
Workload (W)	25	250		

*determined from $220 - \text{age}$ (actual HR_{max} determined by testing prior to AMI was 171 bpm). VO_{2max} , maximal oxygen uptake; VE/ VO_2 , ventilatory equivalent from oxygen; VE/ VCO_2 , ventilatory equivalent from carbon dioxide; RER, respiratory exchange ratio; VT, ventilatory threshold; Freq, frequency or rate of respiration; VE, minute ventilation

between the time of cardiovascular (CV) event and HT is a significant factor in reconditioning and may need to be the focus of HT rehabilitation.

4. Conclusions

In this case study, several months of high volume endurance training immediately following HT showed significant improvement in aerobic capacity and work load. Although this is an unusual case study, it is clear that physical activity immediately following HT and adherence to an individualized program that promotes an active life style helps to restore CV function. These results suggest that a more aggressive approach to HT recovery should be studied.

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