INTRODUCTION: Rate pressure product, is a method to estimate the myocardial oxygen demand during exercise. It can be used as a variable in assessing exercise efficiency.

PURPOSE: To determine the effect of exercise therapy on the myocardial oxygen demand of the heart represented by the rate pressure product (RPP) in complex pediatric congenital heart patients status post Fontan surgery.

We evaluated 14 pediatric post-surgical Fontan patients using a maximal cardiopulmonary exercise test (single ventricle cycle ergometer protocol) before and after a 12 week exercise training program. METHODS: This was a retrospective chart review of patients after a 12 week exercise intervention with pre and post maximal cardiopulmonary exercise tests. Each patient participated two days a week for at least sixty minutes in a supervised exercise program. The program consisted of aerobic and strength training. Data was analyzed at sub-maximal and maximal levels of exercise using a pared student t-test, with a significance level set at 0.05.

RESULTS: There was significant decrease in heart rate at sub-maximal exercise stage 1 and 2 (120±16 vs. 108±5 and 135±18 vs. 120±18) along with a significant decrease in RPP (14799±2438 vs. 12798±2393 and 17881±3188 vs. 15338±3123) when comparing pre versus post exercise training. There was no significant difference in heart rate or RPP at maximal exercise. However there was a significant increase in the maximal indexed oxygen consumption (VO2i) (30.6±5 vs.35.5) along with an increase in exercise time (13.4±2 vs. 15.4±3 minutes). The respiratory exchange ratio did not show a significant change between pre and post test.

CONCLUSION: In this group of Fontan patients participating in a 12 week exercise therapy program, there was a significant decrease in the RPP and heart rate at the submaximal level associated with a significant increase in maximal indexed oxygen consumption and exercise time without a change in submaximal or maximal exercise intensity represented by similar pre and post exercise training respiratory exchange ratios (RER). The exercise training program appears to have improved cardiac performance and efficiency at the submaximal level while increasing aerobic and endurance capacity. In this group of Fontan patients undergoing a 12 week exercise therapy program, their submaximal cardiac performance and efficiency was improved along with their maximal aerobic and endurance capacity.

ABSTRACT

Improved Rate Pressure Product in Pediatric Fontan Patients Undergoing an Exercise Therapy Program

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METHODS:

- Retrospective chart review of referred pediatric cardiology patients status post Fontan procedure and participating in a 12 week exercise therapy program
- Single ventricle cycle ergometer (Lode Corival) cardiopulmonary exercise test protocol, consisting of two separate work progressions based on the patient’s body surface area (BSA)
  - 12 Lead Electrocardiogram (EKG) (GE Case 8000) obtained while supine, standing, each minute of exercise, immediately, 1, 3, 5, 10 & 15 minutes post exercise
  - Blood pressures where obtained by auscultation while supine, sitting, during each stage of exercise, immediately, 1, 3, 5, 10 & 15 minutes post exercise

METHODS cont.:

- Oxygen consumption (VO2) and carbon dioxide production (CO2) were measured at rest and during each staged workload using a metabolic cart (Parvo Medics Model True Max 2400).
- Perceived Exertion rated during each minute of exercise using the 6-20 Borg Scale.
- Subjects exercised until exhaustion.
- All patients achieved a maximal exercise response. Defined as meeting two of the three following criteria: 1) a heart rate ≥ 85% of their theoretical age predicted max, 2) respiratory exchange ratio (RER) ≥ 1.1 and 3) perceived exertion ≥ 18
- Data analyzed at sub-maximal and maximal stages of exercise pre and post exercise program, using a pair student T-test significance set at 0.05
- Participated in an exercise program two times a week for 12 weeks. Which consisted of both aerobic and strength exercises, lasting at least 60 minutes.

RESULTS:

- 14 patients post Fontan surgical repair: 6 were female, 8 male with an average of 12±2.7 years
- 6 HLHS, 5 TA, 2 DILV, 1 D-TGV
- There was significant decrease in heart rate at sub-maximal exercise stage 1 and 2 (120±16 vs. 108±15 and 135±18 vs.120±18)
- A significant decrease in RPP (14799±2438 vs. 12798±2393 and 17881±3188 vs. 15338±3123) when comparing pre versus post exercise training
- No significant difference in heart rate or RPP at maximal exercise
- There was a significant increase in the maximal indexed oxygen consumption (VO2i) (30.6±5 vs.35.5)
- An increase in exercise time (13.4±2 vs. 16.4±3 minutes). The respiratory exchange ratio did not show a significant change between pre and post test.

CONCLUSION:

In this group of Fontan patients participating in a 12 week exercise therapy program, there was a significant decrease in the RPP and heart rate at the submaximal level associated with a significant increase in maximal indexed oxygen consumption and exercise time without a change in submaximal or maximal exercise intensity represented by similar pre and post exercise training respiratory exchange ratios (RER). The exercise training program appears to have improved cardiac performance and efficiency at the submaximal level while increasing aerobic and endurance capacity. In this group of Fontan patients undergoing a 12 week exercise therapy program, their submaximal cardiac performance and efficiency was improved along with their maximal aerobic and endurance capacity.

INTRODUCTION

The Fontan operation is a palliative surgery that creates a stable, passive conduit for pulmonary blood flow in patients with a single ventricle. In a single ventricle heart either the right or left ventricle is large enough to do the normal job of pumping blood to the systemic circulation. In an effort to maximize the hearts efficiency patients to circulate blood through the body like a normal heart.

Patients who have undergone a Fontan surgery, will achieve maximal ventricular efficiency and near normal oxygen saturation level. However, a Fontan heart will still be limited in the work that it can perform. Exercise stress testing has demonstrated the effectiveness of this surgery, but there is very limited data on cardiac rehabilitation, specifically exercise training.

We choose to look at rate pressure product (RPP), which is an estimate of myocardial oxygen demand to see how exercise therapy will affect the cardiovascular efficiency in this clinical population.