Clinical Measurements to Assess the Effect of Controlled Physical Therapy Training for Children with Compensated Heart Failure

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ABSTRACT

The concept that children with rheumatic heart disease are incapacitated should be subjected to assessment. Such children can not be denied from physical activity simply because they have rheumatic heart disease, so long their heart is compensated and show no manifestations of heart failure. This concept does not only attend to their physical activity but also their moral, which reflect its effect on their educational level and recreational participation. Hence the aim of this study was to evaluate the effect of a pre set program of physical training on bicycle ergometer guided by the working capacity in such children. The training program was carried out for 4 months. The blood pressure, heart rate, oxygen consumption and total work capacity were measured before the start and after the completion of the program. The response of the patient to the effort by the appearance of new complaints would be the limiting factor. Twenty four children were with authenticated rheumatic heart disease in a compensated state constituted the experimental group. Ten age and sex matched patients with the same diagnosis were subjected as a control group to the same evaluation procedure but not included in the training program. At the end of the study, the results revealed highly significant improvement ($P<0.001$) versus significant improvement ($P<0.05$) for experimental and control groups respectively for all parameters measured except for blood pressure which revealed non-significant change ($P>0.05$) at the end of the study. From these results, it could be concluded that children with compensated rheumatic heart disease can be safely enrolled in a well supervised cardiac rehabilitation program.

INTRODUCTION

The increased incidence of some heart diseases created the need for careful management. Evaluation of the long-term effects of therapeutic interventions is important for successful management of those children[8].

The beneficial effects of physical training for patients with chronic heart failure were explained in terms of the relationship between the indicator of myocardial oxygen consumption and a given external work load[5].

Also, the heart rate and oxygen up-take were studied in response to exercise in children with low peak exercise heart rate resulting from heart disease[10].

SUBJECTS, MATERIALS AND METHODS

Subjects

- ♦ Thirty four children of both sexes, with compensated rheumatic heart disease (isolated mitral stenosis or double mitral) were participated in the present study.
- ♦ They had past history of heart failure, now they are on diuretic and/or angiotensin converting enzyme inhibitor (ACEI).
- ❁ Patients were excluded from the study if they had any of the following criteria:
- ♦ Presence Presence of heart failure: (orthopnea, paroxmal nuctornal dyspnea [PND], congested pulsating neck veins, bilateral basal crepitation enlarged tender liver, oedema of both lower limbs and cardiac gallop).
- ♦ Irregular pulse, atrial fibrilation (AF) or multiple atrial extra systoles.
- ♦ of complications: (rheumatic activity, subacute bacterial endocarditis (SABE) or hemiplegia).
- ♦ Echocardiographic findings: (mitral valve area is <1.6 cm^2 and/or presence of aortic valve affection).
- ♦ Drugs as digitalis, blockers or Ca channel blockers as they would slow heart rate.
- ♦ Other systemic diseases as chronic lung diseases, anaemia, neuromuscular disease and/or peripheral vascular disease.

- All patients were subjected to full history and medical examination with stress on the cardiac examination and presence of any sign of heart failure.
- They were divided randomly into two groups, an experimental group included 24 children (16 males and 8 females) and a control group of 10 children (6 males and 4 females).
- Their ages ranged between 10 and 14 years with mean of 12.48 2.1 and 11.56 1.74 for experimental and control groups respectively.
- Height, weight and body surface area were determined for all children before the start of the study.

Evaluation Procedures

❁ All children underwent a maximal exercise test on a calibrated electronically braked cycle ergometer a week before the start of

Protocol12, it included the following steps:

- ♦ Three minutes rest.
- ♦ Three to five minutes of unloaded pedaling.
- ♦ Then the work rate was increased 5, 10, 15 watt/min. in relation to body mass index.
- ♦ Patients pedaled at a constant rate of 50-60 rpm until they became fatigue.

❁ The resting heart rate and blood pressure were recorded at the start and the end of the study (after four months) for all patients.

❁ The maximum oxygen consumption (VO_2 max) and the work load were measured for all patients.

❁ The exercise tolerance test was repeated a week after the last training session.

Training Program

Subjects of the experimental group exercised three times/week for 4 months using a cycle ergometer. Each session included a warm-up phase for 3 to 5 minutes of unloaded pedaling, then a working period according to each subject's tolerance and lastly a cool down period of 3 to 5 minutes of unloaded pedaling.

The working period was progressively increased according to the patient's tolerance and the intensity of the training (working

capacity) was adjusted to maintain the pre determined maximum heart rate (HR_{Max}) during the pre training exercise test.

Intensity above the initial predicted maximum heart rate was avoided. This was determined according to Weisman and Zaballos (1995)[13].

[Predicted maximum heart rate = 210 - age * 0.65]

All subjects were asked to perform at 60% to 70% of their HR_{Max}.

RESULTS

Clinical criteria for all patients participated in this study were presented in table (1).

There was non significant difference in blood pressure, at the start of the study for both groups, where the pre systolic mean values were (119.79 2.27 and 120 2.04 mmHg) and the pre diastolic values were (80 0.14 and 79 2 mmHg) for experimental and control groups respectively (P>0.05) (as presented in table 2).

The pre treatment results also revealed non significant differences in other parameters measured (P>0.05), where the pre mean values for experimental group were 86.7 5, 0.504 0.03 and 679.4 122.7 for HR/min, Vo_2 lit/min and total work/watt respectively, versus 89.1 5.59, 0.495 0.015 and 683.7 137.5 for the control group (as presented in table 2).

When the pre and post treatment results were compared for both groups, the results of mean values of HR, VO_2 and total work revealed highly significant improvement (P<0.001) as shown in (table 3), while the improvement was only significantly (P<0.05) in the same parameters for the control group (table 4). These results were illustrated in Fig. (1,2,3).

Concerning the blood pressure, the post treatment results indicated non significant change (P>0.05) in both systolic and diastolic pressure, where the post systolic mean values were 120 2.04 similarly for both groups and the diastolic pressure, mean values were 79.7 2 and 79 2 for experimental and control groups respectively.

At the end of the study, the post treatment mean values revealed highly significant improvement (P<0.001) in the favor of the experimental group for all measuring parameters except for SBP and DBP which revealed non significant change (P>0.05) as indicated in table (5).

Table (1): Criteria of all patients.

Item	Experimental group	Control group
Mean age	12.48 ± 2.1	11.56 ± 1.74
Sex		
Males	16	6
Female	8	4
Diagnosis		
MS	10	4
DM	14	6

MS = Mitral stenosis
DM = Double mitral

Table (2): Comparison of pre treatment mean values of all measured parameters for both groups.

	Experimental $\bar{X}\pm SD$	Control $\bar{X}\pm SD$	MD	t	P	Sig.
SBP	119.79±2.27	120±2.04	0.21	0.246	>0.05	NS
DBP	80±0.14	79±2	1	2.1	>0.05	NS
HR	86.7±5	89.1±5.59	2.4	0.213	>0.05	NS
VO_2	0.504±0.036	0.495±0.015	0.009	0.74	>0.05	NS
TW	679.4±122.7	683.7±137.5	4.3	0.067	>0.05	NS

SBP systolic blood pressure.
DBP diastolic blood pressure.
HR heart rate.
VO_2 oxygen consumption.
TW total work.
NS non significant.

Table (3): Comparison of pre and post treatment mean values of all measured parameters for experimental group.

Item	Pre $\bar{X}\pm SD$	Post $\bar{X}\pm SD$	MD	t	P	Sig.
SBP	119.79±2.27	120±2.04	0.21	0.132	>0.05	NS
DBP	80±0.14	79.7±2	0.3	0.76	>0.05	NS
HR	86.7±5	74.96±4.82	11.75	8.12	<0.001	HS
VO_2	0.504±0.036	0.558±0.027	0.054	5.75	<0.001	HS
TW	679.4±122.7	1086.5±185.6	407.1	8.77	<0.001	HS

NS non significant.
HS highly significant.

Table (4): Comparison of pre and post treatment mean values of all measured parameters for control group.

Item	Pre $\bar{X}\pm SD$	Post $\bar{X}\pm SD$	MD	t	P	Sig.
SBP	120 ±2.04	120±2.04	0	0	>0.05	NS
DBP	79±2	79±2	0	0	>0.05	NS
HR	89.1±5.59	83.8±3.89	5.3	2.33	<0.05	Sig.
VO_2	0.495±0.015	0.516±0.012	0.021	3.28	<0.05	Sig.
TW	683.7±137.5	843.7±142.3	160	2.42	<0.05	Sig.

Sig. Significant.

Table (5): Comparison of post treatment mean values of all measured parameters for both groups.

Item	Experimental $\bar{X}\pm SD$	Control $\bar{X}\pm SD$	MD	t	P	Sig.
SBP	120±2.04	120±2.04	0	0	>0.05	NS
DBP	79.7±2	79±2	0.7	0.903	>0.05	NS
HR	74.96±4.82	83.8±3.89	8.84	5.2	<0.001	HS
VO_2	0.558±0.027	0.516±0.012	0.042	4.59	<0.001	HS
TW	1086.5±185.6	843.7±142.3	242.8	2.75	<0.001	HS

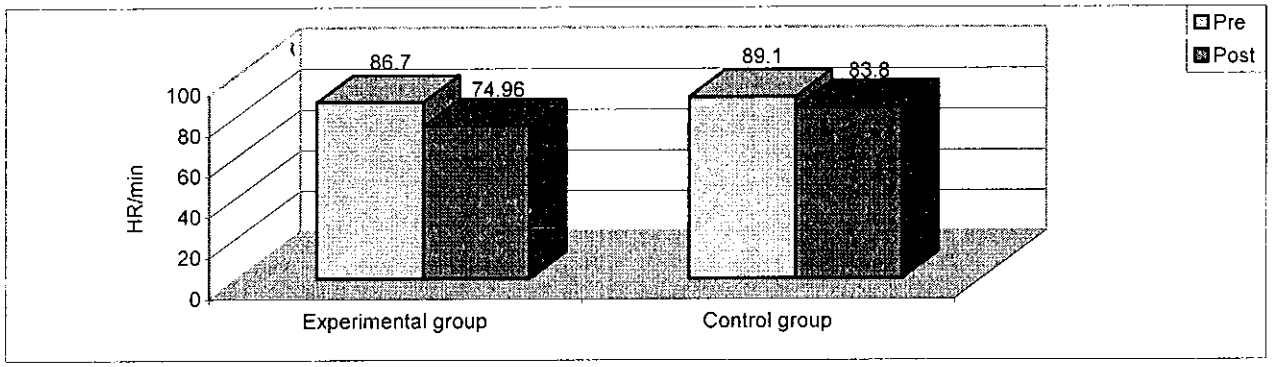

Fig. (1): Pre and post treatment mean values of HR/min for both groups.

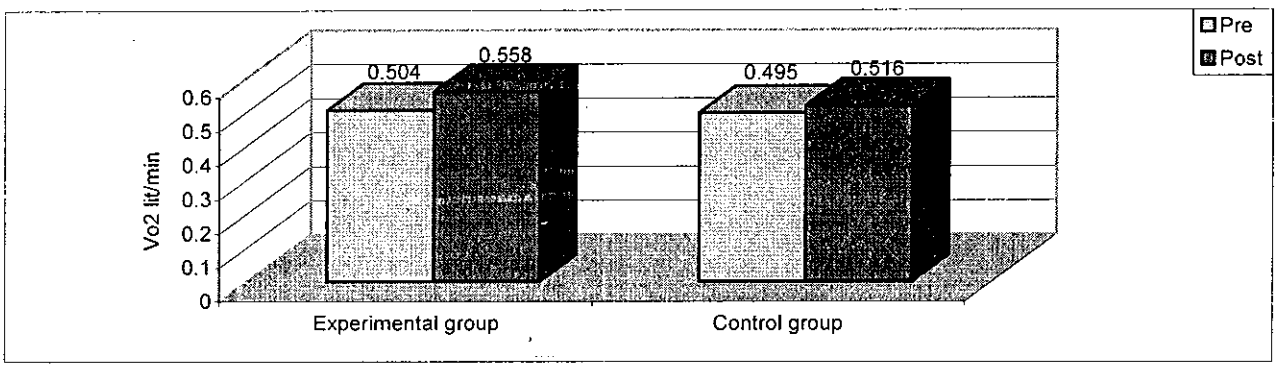

Fig. (2): Pre and post treatment mean values of VO_2 lit/min for both groups.

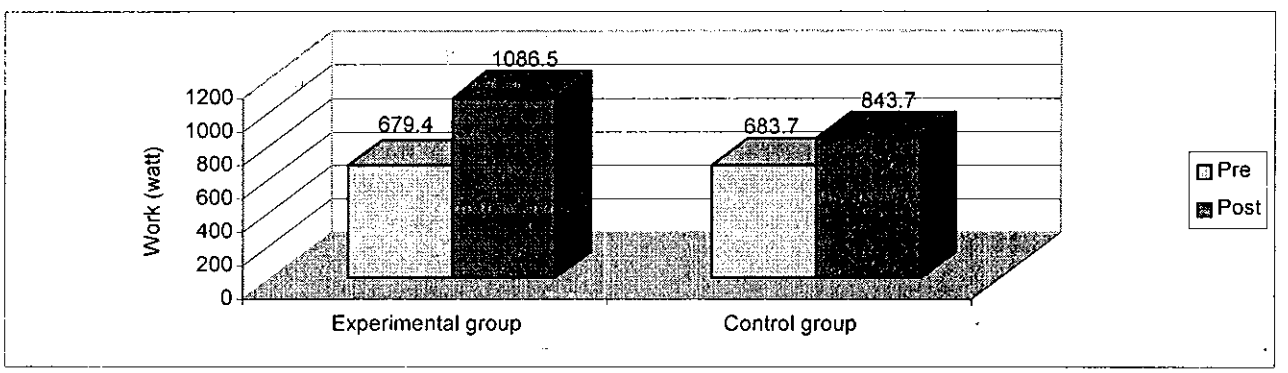

Fig. (3): Pre and post treatment mean values of total work (watt) for both groups.

DISCUSION

Physical therapist working in cardiac rehabilitation centers need to measure physiological variables that reflect the status of the cardiopulmonary system to ensure that patients are progressing safely in therapeutic exercise programs and to monitor responses to treatment procedures.

Measurements of heart rate (HR) and blood pressure (BP) are used to monitor responses to various activities and to establish

safe levels of activity, thus preventing signs and symptoms of exercise intolerance[7]. The measurement of VO_2 max remains the best available index for the assessment of exercise capacity[14].

The results of the present study revealed significant improvement for control group ($P<0.05$) in all parameters measured except for blood pressure. This improvement could be attributed to medical treatment.

Most medication that are prescribed for cardiovascular disease have either a direct or indirect effect on the heart or vascular system, including altering myocardial oxygen consumption. Medications may either increase or decrease exercise capacity[15].

ACEI causes peripheral arterial and venous vasodilatation, sustained decrease in left ventricular filling pressure at rest and on exercise due to vasodilatation, decreased systemic vascular resistance, favorable effect on remodeling, possible improved diastolic function, probable reduced loss of myocardial cells and a negative isotropic effect on the failing heart[3].

Diuretics therapy is indicated in rheumatic heart disease patients with congestion (pulmonary or peripheral)[2] and even in asymptomatic patients[3]. It improves ventricular function, enhances ambulatory care of patients with heart failure or those recovered from heart failure. It helps to prevent recurrent hospitalization[3].

For the experimental group, the results of the present study revealed a highly significant improvement ($P<0.001$) at the end of four months controlled training program using bicycle ergometer 3 time/week.

This could be explained on the basis that a physiologic training effect which could be manifested by a reduction in ventilatory requirement proportional to the reduction in blood lactate which was achieved[4].

Also, this improvement could be related to direct improvement in perfusion of skeletal muscles of exercising limbs[6].

After the conduction of supervised physical training program at the maximum peak aerobic capacity of the patient, improvement could be achieved by facilitating diffusion of blood borne substrates (glucose and oxygen) into the cytoplasm and mitochondria of the muscles cells, and this was suggested by less depletion of phosphocreatinine and inorganic phosphates leading to decrease in anaerobic metabolism during exercise[1].

In addition physical training may cause a number of significant changes in the skeletal muscles of the exercising limbs, including increase in oxygen uptake and arteriovenous oxygen difference at maximal exercise and a decrease in lactate accumulation at sub-maximal exercise with an increase in blood flow[9].

By documenting patient's physiological responses while patients were performing physical activities, the physical therapists can provide valuable feedback to the patient's physicians to guide the medical management.

The results of the present study come in concomitant with those done by Sullivan et al. (1988)[11] who studied the effect of exercise training in patients with chronic heart failure, who reported 23% increase in peak oxygen consumption after 4 to 6 months of training.

Further studies on heart rate and oxygen uptake response to exercise were done by Schulze et al., 1992[10], and the results showed normal exercise VO_2 despite significantly lower heart rate.

SUMMARY AND CONCLUSION

The results obtained from the present study revealed that the controlled physical training on bicycle ergometer produced a significant improvement in cardiac performance, manifested by decrease in resting heart rate and increase in maximum oxygen consumption ($VO_{2\ max}$) and hence this leads to increase in physical work capacity for children with compensated rheumatic heart disease, so it could be concluded that those children could be enrolled safely in well controlled cardiac rehabilitation training programs.

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الملخص العربي

القياسات العملية لتقييم تأثير برنامج العلاج الطبيعي المحكم للأطفال الذين يعانون من حالات هبوط القلب المتكافئ

إن المفهوم بأن إصابة الأطفال بمرض روماتزم القلب يجعلهم معوقين وتحتاج إلى إعادة تقييم وتقويم فلا يمكن أن ينكر على هؤلاء الأطفال القيام بنشاط طبيعي مادامت قلوبهم في حالة تكافئ ولا تظهر لديهم علامات هبوط القلب . وبهذا المفهوم لا يتأثر هؤلاء الأطفال فقط من ناحية النشاط الجسدي بل أيضا أن حالتهم المعنوية وكذلك التعليمية والترويحية قد تتأثر أيضا .

وعلى هذا الأساس فإن الهدف من هذه الدراسة هو تقييم وتقويم أثر برنامج مُعد مقدما للتدريب على جهاز عجلة الثبات مسترشدين بمدى قدرة هؤلاء الأطفال على العمل . والبرنامج التدريبي تم تنفيذه على مدى أربعة شهور ، ولقد تم قياس ضغط الدم ومعدل ضربات القلب واستهلاك الأكسجين والقدرة على العمل قبل بدء البرنامج التنفيذي وبعد استكمال تنفيذه علما بأن تجاوب الأطفال للجهد المبذول كان في حدود ظهور أي أعراض مرضية جديدة .

وشملت الدراسة على 24 طفلا لديهم حالات مؤكدة من روماتزم القلب في وضع متكافئ كمجموعة تجريبية كما شملت أيضا مجموعة ضابطة تتكون من عشرة أطفال من نفس السن والجنس ويعانون من نفس الحالة المرضية ولكن لم يطبق عليهم البرنامج التدريبي وإن كان العلاج الدوائي متماثلاً في المجموعتين .

وفي نهاية الدراسة أشارت النتائج إلى وجود فروق ذو دلالة إحصائية عالية في صالح التحسن للمجموعة التجريبية ($P < 0.005$) عن مقارنتها بالمجموعة الضابطة ($P < 0.05$) . وكان هذا التحسن ذو المغزى الإحصائي واضحا في كافة أبعاد تقييم وتقويم الدراسة فيما عدا قياس ضغط الدم .

ومن هذه النتائج يمكن استنتاج أن الأطفال الذين يعانون من مرض روماتزم القلب المتكافئ من الممكن أن يمارسوا برنامج علاج طبيعي تأهيلي تحت إشراف طبي .