JEPonline
Journal of Exercise Physiology**online**

Official Journal of The American
Society of Exercise Physiologists (ASEP)

ISSN 1097-9751
An International Electronic Journal
Volume 7 Number 4 August 2004

Clinical Exercise Physiology

OUTCOMES OF COMBINING PROGRESSIVE STRENGTH TRAINING WITH AEROBIC TRAINING FOR A WOMAN WITH CHF

ALEXIS SMITH[1], ANN MARIE SWANK[2], KATHLEEN M. KIRBY[3], JOHN MANIRE[2], EMILY ROBERSON[2], RYAN SCHRINK[2], AMY ALLARD[4], D. MARTY DENNY[4].

[1] Spring Arbor University, Spring Arbor, Michigan.
[2] Exercise Physiology, University of Louisville.
[3] Educational & Counseling Psych. Dept., Univ. of Louisville
[4] River Cities Cardiology Cardiac Rehabilitation, Jeffersonville, IN

ABSTRACT

OUTCOMES OF COMBINING PROGRESSIVE STRENGTH TRAINING WITH AEROBIC TRAINING FOR A WOMAN WITH CHF. **Alexis Smith, Ann Marie Swank, Kathleen M. Kirby, John Manire, Emily Roberson, Ryan Schrink, Amy Allard, D. Marty Denny**. **JEP**online 2004;7(4):23-28. Congestive heart failure (CHF) is a chronic form of heart disease characterized by ventricular dysfunction and exercise intolerance. Nearly five million Americans have CHF and over 400,000 new cases are diagnosed each year. As recently as 15 years ago, exercise was not recommended for individuals with CHF due to potential for elevated pressures to cause detrimental changes in ventricular volumes, geometry, and contractility (ventricular remodeling) that may result in acute heart failure. Randomized controlled trials of aerobic training among individuals with CHF have proven safe and beneficial. However, safety and effectiveness of adding strength training to aerobic exercise has not been extensively evaluated in this population especially in women. This case study outlines results for a middle-aged woman with CHF who participated in a combined exercise regimen of progressive strength training and aerobic conditioning. Results of the current case study indicated that progressive high intensity strength training combined with aerobic training resulted in gains in strength and aerobic power without any deleterious effects on ventricular function in a woman with significant heart disease.

Key Words: Exercise, Safety, Heart failure, Women

INTRODUCTION

Case Study #23 is a participant in an NIH funded research project designed to determine the impact of adding progressive strength training to aerobic exercise on aerobic power, muscular strength and ventricular function for individuals with CHF. In addition, personality characteristics including anger, hostility and depression were evaluated. Three experimental groups including aerobic training alone and aerobic training combined with both moderate and high intensity progressive strength training were tested at baseline and following 36 sessions of cardiac rehabilitation. CS #23 was randomized to the combined aerobic and progressive high intensity strength-training group. This data is reported as a case study as NIH has found that the number of women included in clinical trials falls below the number needed to make meaningful statements about women's health. In addition, when women are included in clinical trials there numbers are often not analyzed separately.

The subject is a 54-year old woman weighing 67.7 kg with a height of 163 cm. She has a history of antero-septal myocardial infarction in 1996 treated with PTCA and stent placement. Her medications at discharge included Toprol XL, Prinivil and Pravachol. She was asymptomatic until the summer of 2000 when she noted episodes of chest discomfort and shortness of breath during walking and cutting the grass. Chest pains were random, in that pain was present during an activity on one occasion but not the next. In October of 2000, she had an appointment with her cardiologist and informed him of her symptoms. He suggested she either have a treadmill test or undergo a cardiac catheterization to evaluate possible progression of disease. She opted for the catheterization procedure.

Results of the catheterization procedure showed akinesis of anterolateral, antero-apical, and infero-apical walls, with antero-basal hypokinesis and an ejection fraction of 30%. Coronary artery analysis demonstrated 10% ostial left main coronary artery disease and 60-70% in-stent re-stenosis of the mid LAD artery. Because of these findings, she was admitted to the hospital for a myocardial viability study that was negative. Medical management was decided and her dosage of Prinivil was increased to 20 mg. Since then, she has not complained of any chest discomfort.

In February 2001, her physician again increased her medication of Prinivil to 40 mg daily to achieve maximum benefit with ACE inhibitor therapy and she continues to do well with medical management. Risk factors for the subject included a family history of heart disease as both her mother and father died of myocardial infarction (MI). She works as an accountant and is married and attributes high stress to both her job and marriage. She was placed on lipid-lowering therapy after her MI in 1996. She had been a smoker for most of her life, however, on the night of her MI she quit "cold turkey" and has been smoke-free ever since. Her blood pressure levels have been below 120/80 likely due to medical management with Toprol XL and Prinvil.

METHODS

In September of 2003, subject enrolled in our NIH-sponsored study and was randomized to the high intensity progressive strength and aerobic training group. Her aerobic power was measured on a treadmill using the modified Naughton protocol and a Parvo-Medics Metabolic system (Sandy, UT). Ventricular function was measured with echocardiography performed during a standard lifting test as recommended by Evans (1). The lifting test consisted of a warm-up set performed at 50% of pre-determined 1-repetition maximum (1RM) followed by three sets of exercise performed at 70% of 1RM. Echocardiograms were performed at rest and during the last repetition for each of three sets of leg press exercise consistent with the recommendations of the American Society of Echocardiographers (2). Leg press was chosen since previous research has identified this exercise as producing the greatest change in blood pressure in comparison to other strength training exercises (3). Subject was positioned on the leg press (Trotter-Cybex International, Inc., Medway, MA) with knees and hips at 90° of flexion and arms resting on the pads beside the head. Resting heart rate was obtained using a CM_5

monitoring lead and blood pressure was measured using standard auscultation with a sphygmomanometer and stethoscope.

A Hewlett-Packard Sonos 5500 Ultrasound Imaging system with a handheld wide-band transducer obtained images that were then recorded on Super VHS videocassette for playback and analysis. Analysis was carried out by trackball on monitor using the Sonos 5500 on-board computer by a certified sonographer. End diastolic volume (EDV) and the corresponding end systolic volume (ESV) of each cardiac cycle visible during the lifting phase of the last repetition of each set were analyzed. Apical-4 chamber views were used to calculate ventricular volumes using the Modified Simpson's rule assumption based on stacked disk and values reported were the mean of these cycles (4) Ejection fraction was calculated using the formula (EDV-ESV)/ EDV.

Muscle strength was measured by the 1-RM method according to accepted standards (5) for leg press, horizontal squat, shoulder press, leg extension, latissimus dorsi (lat) pulldown, and biceps curl exercises. All strength measurements were made with identical equipment positioning and technique before and following 12-weeks of training.

The Spielberger State-Trait Anger Expression Inventory, Second Edition (STAXI-2, 6) and Brief Symptom Inventory (BSI, 7) were also administered before and after training. The STAXI-2 is designed to measure the experience, expression and control of anger for adolescents aged 16 and over and adults and consists of six scales: State Anger, Trait Anger, Anger Expression-Out, Anger Expression-In, Anger Control-Out and Anger Control-In; five subscales: State Anger-Feeling, State Anger-Verbal, State Anger-Physical, Trait Anger-Temperament, and Trait Anger-Reaction; and an Anger Expression Index. The STAXI-2 consists of three parts each asks respondents to endorse a 4-point Likert-like scale (1 = Not at all or almost never to 4 = Very much so or Almost always): How I feel right now (15 items), How I generally feel (10 items), and How I generally act when angry or furious (32 items).

The BSI is a 53-item symptom inventory designed to indicate the psychological symptom patterns of psychiatric and medical patients as well as the general population. Respondents are presented with a list of problems people sometimes have and are asked to denote how much that problem has distressed or bothered them during the past 7 days including the current day. The subjects endorse each item of the BSI on a five-point scale of distress (0 to 4) ranging from "not at all" (0) at one pole to "extremely" (4) at the other. The primary dimensions are: Somatization, Obsessive-Compulsive, Interpersonal Sensitivity, Depression, Anxiety, Hostility, Phobic Anxiety, Paranoid Ideation, and Psychoticism. Global indices include: Global Severity Index, Positive Symptom Total, and Positive Symptom Distress Index. These indices indicate a general level of psychological well-being.

Her exercise-training program consisted of cardiovascular training three days a week and strength training two days a week for 36 sessions. She trained 15 min on both the treadmill and Schwinn air dyne bike (Boulder, CO) at 60 to 80% of her heart rate reserve following a five minute warm up at 50% of heart rate reserve. Exercise intensity was increased 0.5 METS/week consistent with patient tolerance. During training, heart rate and rhythm were monitored continuously using a Nihon-Kohden WEP-9430 Cardiac Telemetry System. The following exercises were used for strength training: leg press, shoulder press, leg extension, lateral pulldown, cable biceps curl, and horizontal squat starting at 50% of her 1RM and progressing to 80%. During weeks 1 and 2 she worked at 50% and 60% of her 1-RM respectively. During week 3 she worked at 70% of her 1RM. For weeks 4-12, she trained at 80% of her 1-RM.

RESULTS

Table 1 lists results of the treadmill test. Results indicated a 14% increase in VO_{2max} and a 35% increase in MET level achieved. Increased aerobic power was accomplished with nearly identical maximal heart rate and blood pressure responses and decreased symptoms. Results indicate that subject showed improvement in aerobic power over the 12 weeks of training.

Table 1. Treadmill test results from baseline and 12-weeks of training with %change.

Variable	*Baseline*	*12 Weeks*	*% Change*
Weight	67.7	65.9	2.6
Rest-HR	72	73	0
Rest-SBP	128	110	14
Rest-DBP	82	68	17
Peak VO2	15.7	21.5	14
Peak METs	4.5	6.1	35
Peak Workload	3.0 mi/hr:12.5 %	3.4 mi/hr:14.0 %	--
Peak-RER	1.07	1.16	8
Peak-HR	141	147	4
Peak-SBP	180	180	0
Peak-DBP	84	84	0
Peak-RPE	16	19	19
Symptoms	2+ angina	none	

Abbreviations- HR (heart rate, beats/minute)), SBP (systolic blood pressure, mmHG), DBP (diastolic blood pressure, mmHG), VO_2 (oxygen uptake, ml/kg/min), METS (metabolic equivalents of task), RER (respiratory exchange ratio), RPE (ratings of perceived exertion)

Table 2 lists 1RM results for each strength-training exercise and Table 3 provides data for ejection fraction (EF) response obtained during the standard lifting task. She demonstrated substantial percentage gains in strength over a 12-week training program. These gains were achieved with no detrimental change in ventricular function as indicated by the EF results for the standard lifting task. Ejection fraction results with the echo indicated stable ventricular function throughout the 12 weeks of training.

Table 2. Strength training results at baseline and following 12-weeks of training.

Variable	*Baseline*	*12 Weeks*	*% Change*
Leg press	69.7	110.6	59
Leg extension	41.8	62.7	50
Lat pull down	37.6	50.2	34
Squat	18.2	34.5	90
Shoulder press	27.8	27.8	0
Cable bicep-curl	29.3	37.6	28

Table 3. Echocardiography ejection fraction results at baseline and following 12-weeks of training.

Variable	*Baseline*	*Peak Set 1*	*Peak Set 2*	*Peak Set 3*
EF Week 0	19	35	33	39
EF Week 12	19	37	38	37

Analysis of STAXI-2 and BSI results indicated that she presented a stable personality pattern that did not change over 12-weeks of training. No significant psychological symptoms were endorsed on the BSI. Her performance on the STAXI-2 suggests that others view her as an individual in control of her negative emotions.

However, it is likely that she relies excessively on the defenses of denial and repression to achieve this control—a strategy that requires a great mental and physical energy to monitor the experience of anger and prevent its expression. She is probably unaware of any of her angry feelings and, thereby, is not actively or consciously engaging in stress-reduction strategies that most individuals employ to attenuate their frustration and anger. As such, she will be surprised and distressed when angry feelings leak out. It is possible that she will be drawn to activities that help disperse internalized anger, such as aerobic exercise or mindful meditation (e.g., yoga or Tai Chi). If so, she may feel a compulsion to strictly adhere to her established regime without realizing the emotional benefits.

DISCUSSION

Congestive heart failure (CHF) is a chronic form of heart disease characterized by ventricular dysfunction and exercise intolerance. Nearly five million Americans have CHF and over 400,000 new cases are diagnosed each year (8). The incidence of CHF is 10 per 1,000 for individuals over 65 years of age and is the most common cause of hospitalization for this age group (8). With the "graying of America" interventions such as exercise training that have potential to limit hospital re-admissions and subsequent costly procedures will be important for cost effective disease management.

Recent recommendations for exercise prescription include adding strength training to aerobic conditioning to maximize benefits of exercise training. Strength training provides benefits complementary to aerobic training and include; preservation of lean muscle tissue, increased bone mineral content, decreased falls, and enhanced quality of life. More importantly, improvements in strength allow individuals to perform routine lifting tasks with a lower cardiovascular response, at a lower percent of their maximal strength level, and with greater efficiency of movement impacting quality of life. Performance of activities of daily living may be more impacted by increases in muscular strength than aerobic power.

Women participating in cardiac rehabilitation programs exhibit decreased exercise attendance, emotional problems, and a lack of effort in comparison with their male counterparts (9,10). These characteristics are related to reduced self-efficacy, increased anxiety, and activity intolerance (9,10). It should be noted that although women have lower ratings of self-efficacy at baseline and at the end of cardiac rehabilitation programs, they display similar degrees of physical improvement (11). Results of the current case study indicate that progressive high intensity strength training combined with aerobic training results in significant gains in strength and aerobic power without any deleterious effects on ventricular function in a woman with significant heart disease.

Kneip et al. (12) found that the trait of anger and hostility significantly elevated the risk of heart disease. With the subject unaware of her trait of anger/hostility she is likely uninformed about the benefits exercise provides in lowering her risk for progression of disease. It is important to recognize that many individuals may derive positive emotional as well as physical benefit from aerobic and strength training and that emotional modulation often contributes to physical well-being. Adding questionnaires such as the STAXI-2 and BSI that measure personality characteristics related to heart disease may assist cardiac rehabilitation staff to identify appropriate care for their participants.

ACKNOWLEDGEMENTS

Work supported by an NIH, (NHLBI) grant #1R15HL65280-01A.

Address for correspondence: Ann Marie Swank, Exercise Physiology Lab, Crawford Gym Room #2, University of Louisville, Louisville, KY 40292; Phone: (502) 852-8351 (office); FAX: (502) 852-4534; Email: swank@louisville.edu

REFERENCES

1. Evans WJ. Reversing sarcopenia: How weight training can build strength and vitality. ***Geriatrics*** 1996;51:46-53.
2. Feigenbaum H. **Echocardiography**. 1986, 4th Edition, Lea & Febiger, Philadelphia.
3. Haslam RS, McCartney N, McKelvie RS, MacDougall JD. Direct measurement of arterial blood pressure during formal weightlifting exercise in cardiac patients. ***J Cardiopulmonary Rehabil*** 1988;8:213-225.
4. Albin G, Rahko PS. Comparison of echocardiographic quantitation of left ventricular ejection fraction to radionuclide angiography in patients with regional wall abnormalities. ***Am J Cardiol*** 1990;65:1031-1032.
5. Fleck SJ and WJ Kraemer. ***Designing Resistance Training Programs*** 1997, 2nd edition, Champaign, IL: Human Kinetics, 1997
6. Spielberger CD. **STAXI-2 State-Trait Anger Expression Inventory-2: Professional Manual.** 1999, Lutz, FL: Psychological Assessment Resources, Inc.
7. Derogatis, LR. **BSI: Brief Symptom Inventory: Administration, Scoring and Procedures Manual**. 1993, Minneapolis, MN: National Computer Systems.
8. Biddle S. **Understanding Congestive Heart Failure.** 1988. National Institutes of Health, U.S. Department of Health & Human Services.
9. Schuster PM, Waldron J. Gender differences in cardiac rehabilitation patients. ***Rehabilitation Nursing*** 1991;16:248-253.
10. Rhodes RE, Martin AD, Tauton JE. Temporal relationships of self-efficacy and social support as predictors of adherence in a 6-month strength training program for women. ***Perceptual and Motor Skills*** 2001;93:693-703.
11. Gardner, J, McConnell, T, Klinger, T, Herman, C, Hauck, C, and Laubach, C. Quality of life and self-efficacy: Gender and diagnoses considerations for management during cardiac rehabilitation. ***J Cardiopulmonary Rehabil*** 2003;23:299-306.
12. Kneip, RC, Delamater, AM, Ismond, TMC. Self- and spouse ratings of anger and hostility as predictors of coronary heart disease. ***Health Psychology*** 1993;12:301-307.