Effect of Cardiac Rehabilitation (Resistance Training) in CABG’s Patients

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Abstract: Cardiac rehabilitation (CR) in patients with coronary artery disease (CAD) has numerous beneficial effects, including the improvement of the prognosis and modification of coronary risk factors. There are limited data that are available regarding the effects of CR with resistance training in patients after coronary artery bypass grafting (CABG). So the purpose of this study was to evaluation the effect of cardiac rehabilitation with resistance training in CABG’s patients. In this study, 32 patients after coronary artery bypass grafting (CABG) volunteer for test were selected, 16 person with 58/13±5/135 years old as an experimental group and 16 subjects with 57/18±4/257 years old, selected as a control group randomly. All data are expressed as the mean value ± standard deviation. Data at the baseline and after training intervention (2 months) were compared in each patient by the paired t-test. To determine the effect of treatment within each group was used ANOVA for repeated measures. Results showed the increase in the arm and leg strength respectively 4% and 12% P < 0.001 between groups. After the cardiac rehabilitation, neither group experienced a significant change in body weight and BMI. Total exercise time achieved was significantly improved in both experimental and control groups from baseline. Neither intervention changed in left ventricular area ejection fraction for both groups. The MetS score was significantly decreased after cardiac rehabilitation from 3.5±0.8 to 2.3±1.0 in experimental group and from 3.7±0.6 to 2.4±0.7 in control group (p < 0.001). Result showed that also there was a significant increase in peak VO2 (ml.kg⁻¹.min⁻¹) from baseline averaged 16% (P < 0.05) for control group and 9% (P<0.05) for experimental group, however, compare between groups showed that there was statistical significance. Since the achieved benefits of CR in CABG’s patients are highly dependent on patient compliance, it is necessary to make plans for safe and enjoyable cardiac rehabilitation programmers’ to increase patient compliance and motivate patients to incorporate regular physical activity in their everyday life.

Key words: Cardiac rehabilitation; Resistance training; Coronary artery bypass grafting (CABG).

INTRODUCTION

The benefits of cardiac rehabilitation in coronary artery disease (CAD) are well established. Recently studies guidelines now recommend a regular program of cardiac rehabilitation for many patients with stable coronary artery disease (Pina, et al., 2003; Swedberg, et al., 2005). The primary concern of phase II cardiac rehabilitation is the reconditioning of the heart muscle after a cardiac event such as a coronary artery bypass graft (CABG), pacemaker, myocardial infarction (MI), or angioplasty. In addition, rehabilitation programs attempt to aid in the improvement of coronary artery disease (CAD) risk factor profile, increase productivity and independence alleviate or decrease activity-induced symptoms and assist in the resumption of daily occupational and recreational activities (Spencer, 2007). Many phase II cardiac rehabilitation patients suffer from atrophy and general musculoskeletal weakness caused by inactivity associated with recovery, sedentary lifestyle, or old age. Therefore, patients often lack the capacity or the confidence to perform everyday living tasks and so their psychological and emotional well-being frequently suffers. The addition of resistance training (RT) to usual-care, a cardiovascular-only program offers solutions to these problems that are not effectively addressed by usual-care programs alone (Spencer, 2007). When compared with cardiovascular exercise, RT tends to produce fewer ischemic responses and arrhythmias; has no apparent adverse effects on the left ventricle; produces higher diastolic blood pressure, which may facilitate coronary perfusion; and lowers heart rates (Spencer, 2007; Verrill & Ribisl).

Haennel et al. (1994), Verrill and Ribisl found that a 12-week RT program lowered heart rate, systolic blood pressure and rate of perceived exertion (RPE) during 3 activities of daily living, whereas no such changes were found in a control group participating in a walk-jog-cycle program. RT, in particular circuit weight training (CWT), also improves various measures of aerobic capacity among cardiac rehab patients, with total time and perceived effort being the most affected.

Cardiac rehabilitation (CR) program has been shown to reduce morbidity and mortality (Specchia, et al., 1996) and improve exercise capacity in patients with acute cardiovascular disease (CVD) or myocardial infarction (AMI). Functional of the lower limb muscle is an important peripheral factor in cardiac
function (Kida, et al., 2006). Some studies have reported that the combination of aerobic and resistance training was effective to increase skeletal muscle volume (Beniamini, Rubenstein, Faigenbaum, Lichtenstein, and Crim, 1999; Fragnoli-Munn, Savage, and Ades, 1998; Stewart, et al., 1998). Cardiac rehabilitation (CR) has numerous helpful effects, including the improvement of the prognosis and modification of coronary risk factors, in patients with coronary artery disease (CAD). The recommendations by The American Heart Association describing the rationale for participation and considerations for prescribing RT were published in 2000 (Pollock, et al., 2000). Resistance training can be defined as any methods that use progressive resistance to increase muscular strength. Using this definition the practitioner can design programs which utilize body segments and body mass as the resistance, springs, elastic bands, free-weights or an assortment of machines.

Exercise training is a safe and effective intervention to improve aerobic capacity (VO\textsubscript{2peak}) in clinically stable heart failure patients (Rees, Taylor, Singh, Coats and Ebrahim, 2004). The improvement in VO\textsubscript{2 peak} has been attributed to favorable changes in cardiovascular and skeletal muscle function (Hambrecht et al., 2000; Sullivan, Green, & Cobb, 1990). Currently, the benefits of exercise training in heart failure are primarily based on aerobic training interventions (Belardinelli, Georgiou, Cianci, & Purcaro, 1999). The few investigations examining the effect of combined aerobic and resistance training have mainly focused on outcomes related to the muscular strength, with less emphasis on cardiac function and functional capacity (Hambrecht et al., 2000; Magnusson, et al., 1996; Maiorana et al., 2001; Stewart et al., 1998). Accordingly, the cardiac and skeletal muscle benefits of aerobic versus combined aerobic and resistance training remain largely unknown. These advantages have made RT an accepted component of programs for health and fitness.

There are very limited studies that are available regarding the effects of CR with RT on the physical status and risk factors especially functional capacity in patients with metabolic syndrome (MetS) after coronary artery bypass grafting (CABG). Which method to use will depend on many practical considerations such as physical and financial resources and staffing? This article will provide some practical guidelines for incorporating resistance training in cardiac rehabilitation for CABG’s patients program. The purpose of this study was to examine the effects of resistance training and aerobic training on functional capacity, left ventricular systolic function and skeletal muscle strength and endurance, in CABG’s patients. Our hypothesis was that compared aerobic training would result in a greater improvement in muscle strength and endurance and functional capacity with resistance training.

**Methods:**

**Participants:**

The study population consisted of 65 patients with CVD who were referred to our rehabilitation laboratory by researchers, in order to participate in the rehabilitation program. Among 65 patients, 32 patients after coronary artery bypass grafting (CABG) volunteer for test were selected. In this study 16 person with 58\pm5/135 years old as an experimental group and 16 subjects with 57\pm4/257 years old, selected as a control group randomly. All participants completed the questionnaire about the history of their CVD and informed consent and the protocol was approved by the Institutional of Emam ali,s Hospital in Kermanshah on issues of ethics, health and safety.

**Strength Measures:**

To learn proper technique and minimize muscle soreness patients began resistance training for a week with very light weights. All patients performed single-repetition maximal lifts (1-RM) for the leg extension, leg curl, lateral raise, arm curl, triceps kickback and bench press on a Gym to assess strength. The 1-RM is defined as the maximum resistance a patient can lift, using correct form, through a full range of motion, for no more than one repetition only. After the familiarization, the tester selected a weight and asked the subject to perform the lift. After 5 min, the process was repeated with heavier weights until the patient could not complete the full lift. Subsequently, patients in the resistance training updated the 1-RM and then the resistance training intervention. To estimate the likelihood of subjects exceeding safe levels of myocardial work during resistance training, an indirect measure of myocardial work was calculated: the rate– pressure product (RPP): heart rate (beats per minute) _ systolic blood pressure (mm Hg).

**Body Mass Index:**

To calculate the body mass index body (BMI; kg/m\textsuperscript{2}), weight (0.1 kg) and height (0.1 cm) were measured.

**Exercise Treadmill Testing:**

To assess a symptom- limited we used electrocardiographically monitored exercise test on treadmill. Before, middle and after the exercise program we used Balke protocol, which advances exercise intensity at 1-MET intervals. If the low threshold angina or 2-mm ST segment shifted on the ECG excluded subjects from the training protocol we stopped the training. In this protocol we checked the peak oxygen consumption (peak VO\textsubscript{2peak}).
O2) in milliliters per kilogram per minute was the highest 30-s value (Froelicher, et al., 1974). It is applied for an assessment of functional capacity, as a simple prognosticator.

Control Group:
Control group performed Cardiac Rehabilitation three times per week for 8 weeks (24 sessions). Each session consisted of 15 min warm-up, such as stretching and respiratory exercise. Then, participants exercised 15 min on a cycle ergometer and 15 min on a treadmill. Training intensity was individualized based on ventilatory threshold (VT) power (w). Exercise training was monitored and controlled by a computer system that connected with the treadmill and training ergocycles.

Resistance Training Intervention:
For experimental group, resistance training was performed three times per week for 8 weeks (24 sessions). In this study was used resistance training recommendations from the American College of Sports Medicine (ACSM) for patients who have coronary artery bypass graft (CABG). The resistance training program was established on the basis of baseline 1-RM lifts. Patients performed 1-RM testing for six exercises, at the first day of training. Weight training began at 50% of 1-RM and training intensity was gradually increased toward 75% of 1-RM, as tolerated. The six exercises focused on arm, shoulder and leg strength. Resistance training included 1) bench press, 2) arm curls, 3) lateral raise, 4) leg curl, 5) leg extensions and 6) triceps kickback. Patients began resistance training with one set of 10 repetitions, gradually increasing to two and three sets with a 2-min rest in between each set (Figur1).

Met Score:
In the current study, the MetS score (from 0 to 5) was defined by the number of criteria of the adjusted Adult Treatment Panel criteria of the National Cholesterol Education Program. Each criterion, was utilized following the original definition (Antonopoulos, 2002).

<table>
<thead>
<tr>
<th>Bench Press</th>
<th>Arm Curls</th>
<th>Lateral Raise</th>
<th>Leg Curl</th>
<th>Leg Extension</th>
<th>Triceps Kickback</th>
</tr>
</thead>
</table>

Fig. 1: Sample of the Resistance Training.

Monitoring:
Obtaining a diagnostic quality ECG during resistance exercises which require "fixing" of the thorax (all upper body and during strong efforts with the lower limbs) is extremely challenging, due to inference by chest muscle EMG activity. Moreover, as research evidence suggests that resistance training provokes fewer ECG abnormalities and signs and symptoms of ischemia than aerobic training (McCARTNEY, 1998), ECG monitoring is not essential. The measurement of blood pressure can be useful, but is only valid if the recordings are taken during the actual lifting, from a non-engaged limb. Measurements after lifting are not representative of the pressure during the maneuver and may even be below resting levels (Wiecek, McCartney, & McKelvie, 1990).

Statistics:
In this study all data are expressed as the mean value ± standard deviation. Data at the baseline and after training intervention (2 months) were compared in each patient by the paired t-test. To determine the effect of treatment within each group was used ANOVA for repeated measures. Probability p-values less than 0.05 were considered significant.

RESULTS AND DISCUSSION

In this investigation participants randomly assigned in two groups. Thirty-two of the patients completed the protocol of this intervention. All participants in this investigation had not any orthopedic problems. There weren’t significant baseline differences between two groups (experimental and control) for age, gender, weight, peak Vo2, body mass index and area ejection fraction.
After resistance training, compare between experimental group and control group showed the increase in the arm strength (59 vs. 4% $P < 0.0001$ between groups) and leg strength (50 vs. 12% $P < 0.001$ between groups), measured by single-repetition maximal lifts. After the cardiac rehabilitation, neither group experienced a significant change in body weight and BMI. Total exercise time achieved was significantly improved in both experimental and control groups from baseline. Neither intervention changed in left ventricular area ejection fraction for both groups.

The MetS score was significantly decreased after cardiac rehabilitation from $3.5±0.8$ to $2.3±1.0$ in experimental group and from $3.7±0.6$ to $2.4±0.7$ in control group ($p < 0.001$).

After completed the experimental protocol, result showed that there was a significant increase in peak VO$_2$ (ml/kg · min$^{-1}$) from baseline averaged 16% ($P < 0.05$) for control group and 9% ($P<0.05$) for experimental group, however, compare between groups showed that there was statistical significance (Table1).

**Table 1:** Clinical characteristic of the Experimental and Control groups, before and after intervention the Cardiac Rehabilitation.

<table>
<thead>
<tr>
<th></th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>$P$ Value Between Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Age (year)</td>
<td>58.13±5.135</td>
<td>57.18±4.257</td>
<td>0.56</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>86.7±9.23</td>
<td>84.5±9.12</td>
<td>85.4±8.45</td>
</tr>
<tr>
<td>Body mass index (kg/m$^2$)</td>
<td>28.9±4.3</td>
<td>27.3±</td>
<td>28.7±4.5</td>
</tr>
<tr>
<td>Vo2peak (ml/kg per min)</td>
<td>14.8±2.51</td>
<td>17.6±3.42</td>
<td>15.8±2.34</td>
</tr>
<tr>
<td>Left ventricular area ejection fraction (%)</td>
<td>30.1±2.35</td>
<td>30.9±2.34</td>
<td>29.8±2.36</td>
</tr>
<tr>
<td>1-RM leg, (kg)</td>
<td>29.7±8.7</td>
<td>45.3±11.3</td>
<td>31.3±12.4</td>
</tr>
<tr>
<td>1-RM arm, (kg)</td>
<td>20.9±9.8</td>
<td>32.5±10.3</td>
<td>19.4±6.5</td>
</tr>
<tr>
<td>Exercise time (min)</td>
<td>11.3±4.1</td>
<td>13.2±3.2</td>
<td>11.1±4.2</td>
</tr>
</tbody>
</table>

**Fig. 2:** Vo2 peak (ml/kg per min) before and after Cardiac Rehabilitation on Experimental group.

**Fig. 3:** Vo2 peak (ml/kg per min) before and after Cardiac Rehabilitation on Control.

**Discussion:**

The present study was performed to assess the effects of resistance training and aerobic training on functional capacity and skeletal muscle strength in men with CABG. The current study showed that CR including resistance and aerobic training for 2 months ameliorated not only metabolic parameters, but also the
muscle strength, exercise capacity, in MetS patients after CABG. Some of the researchers and we reported the impact of MetS on clinical effects in patients with coronary artery disease (Kasai, et al., 2006; Lakka, et al., 2002). Although it has been clarified that exercise decreases the prevalence of MetS (Blair and Church, 2004; Savage, Banzer, Balady and Ades, 2005), the beneficial effects of CR in patients with MetS, are still unclear. Shubair et al. reported that CR resulted in a significant improvement in the, body weight, exercise capacity and other cardiovascular risk profiles; however, this investigation also consisted of patients with various diagnoses of coronary artery disease(Shubair, Kodis, McKelvie, Arthur, and Sharma, 2004). It has been manifestly established that exercise tolerance is a good predictor of the prognosis in patients with cardiovascular diseases (Belardinelli, et al., 1999; Chua, et al., 1997). The WHO suggested that increased muscle strength cause an improved long term prognosis (Organization, 1995).

Delagardelle et al., (2002), reported that four months of cardiac rehabilitation which including combined aerobic and resistance training was superior to aerobic training for improving peak of Vo2, systolic function and muscular strength in patients with cardiovascular disease (Delagardelle, et al., 2002). In contrast, Haykowsky et al., (2005), found that supervised combined resistance and aerobic training improved upper extremity muscle strength compared to the aerobic training group while the change in peak of Vo2 and lower extremity strength were not different between combined aerobic and resistance training and aerobic training(Haykowsky, MUHLL, Ezekowitz, and Armstrong, 2005). Our finding showed that resistance training improved both upper and lower extremity muscle strength.

The results of this study suggest that both resistance and combined aerobic and resistance training are similarly effective and may be used interchangeably for improving muscles strength and exercise tolerance in CABG’s patients, depending on patient’s preference. However, combined aerobic and resistance training may be a preferable intervention to aerobic training only in CABG’s patients. From a clinical perspective, regular exercise may be beneficial in CABG’s patients even if it does not significantly improve Vo2peak but prevents the decline in Vo2peak that is exacerbated by sedentary lifestyle.

If RT were to be widely adopted as part of a healthy lifestyle for CABG’s patients, it could potentially lead to wide ranging functional effects that include improved walking endurance and physical functioning and increased daily caloric expenditure (Brochu et al., 2002; Pu et al., 2001). Since the achieved benefits of CR in CABG’s patients are highly dependent on patient compliance, it is necessary to make plans for safe and enjoyable cardiac rehabilitation programmers’ to increase patient compliance and motivate patients to incorporate regular physical activity in their everyday life.

There are several limitations to our study. First, this study the possessed a small trained patients sample size. However, we were able to detect significant differences in the variables studied between resistance and aerobic training groups. Moreover, use of different types of cycle ergometers in aerobic training might have affected muscular strength and muscular endurance results in the present study. Furthermore, outcome assessors were not always blinded to the patients’ group assignment. Future research requires comparing clinical and physiological benefits of resistance training and aerobic training in CABG’s patients in prospective, large, randomized controlled studies of longer duration.

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