Original Article

Effect of Cardiac Rehabilitation Phase II Training on Calf Strength in CABG Patients

Sumaiyah Ansari,[1] **Mirza Obaid Baig,**[2] **Uzma Arif Baig**[3]

Abstract

While there has been considerable research on calf muscle strengthening in post CABG patient focused on calf muscle because in CABG for bypass graft lower leg graft preferred by that muscle activity compensate due to grafting. In exercise prescription it associated with cardiac endurance maintenance of perceived exertion level. Criteria to evaluate pre-test and post test (experimental study) a one tail hypothesis, improvement in calf muscle grading through manual muscle testing. Fifty post CABG patients in Cardiac rehabilitation phase II, 45 – 65 years of age, both female and male gender enrolled. Patients completed eighteen sessions of exercise program with cardiac endurance and muscle strengthening. Patient performed cool down and warm up with calf stretching exercise. Treadmill and recumbent bike duration and work load increased gradually to strengthen the muscle, as well patients monitored closely by telemetry to interpretation of ECG, heart rate and blood pressure pre, during and post exercise in all eighteen session of exercise. The result after exercise treatment showed significantly improvement in calf muscle grading from initial to final assessment (p value > 0.10) null hypothesis accepted. In conclusion eighteen sessions programmed cardiac rehabilitation phase II significantly helpful for increase in muscle grading of calf muscle in post CABG patients.

Keywords: CABG, Cardiac Rehabilitation, Phase II, Calf muscle, manual muscle testing.

Introduction

Heart is a muscular pump that circulates the blood. An adult human heart weighs between 200 and 425 grams (7 and 15 ounces) and is slightly larger than a fist. In an average lifetime, a person's heart may beat more than 3.5 billion times. Each day, the average heart beats 100,000 times, pumping about 7,600 liters (2,000 gallons) of blood. Circulatory systemis responsible, to transport nutrients, wastes**,** oxygen and carbon dioxide and hormones. Two pumps (in a single heart) one to pumped oxygenated blood to the lungs; the other to pumped oxygenated blood to all other organs and tissues of the body. Coronary circulation is the circulation of blood in the blood vessels of the heart muscle (the myocardium). In general there are two main coronary arteries, the left and right coronary arteries and also posterior coronary artery. The artery that supplies the posterior descending artery (PDA) posterior inter-

Ansari S.[1]
Staff Physiotherapist, Liaquat National School of Physiotherapy, Aga Khan University Hospital, Karachi

Baig M.O.[2]
Assistant Professor of Physiotherapy
Ziauddin University Hospital, Karachi

Baig U.A.[3]
Senior Lecturer, Liaquat National School of Physiotherapy
Aga Khan University Hospital, Karachi

ventricular artery determines the coronary dominance. If PDA is supplied by the right coronary artery (RCA), then the coronary circulation can be classified as right-dominant. If the posterior descending artery (PDA) is supplied by the circumflex artery (CX), a branch of the left artery, then the coronary circulation can be classified as left – dominant. If the posterior descending artery (PDA) is supplied by both RCA and CX, then the coronary circulation can be classified as co-dominant.

Approximately 70% of the general population is right – dominant, 20% are co-dominant, and 10% are left – dominant. The coronary arteries that run on the surface of the heart are called epicardial coronary arteries. These arteries, when healthy, are capable of autoregulation to maintain coronary blood flow at levels appropriate to the needs of the heart muscle. These relatively narrow vessels are commonly affected by atherosclerosis and can become blocked, causing angina or a heart attack. The coronary arteries that run deep within the myocardium are referred to as sub endocardial. The coronary arteries are classified as end circulation, since they represent the only source of blood supply to the myocardium, which is why blockage of these vessels can be so critical. Failure of oxygen delivery caused by a decrease in blood flow in front of increased oxygen demand of the heart results in tissue ischemia. Brief ischemia is associated with intense chest pain, known as angina. Severe ischemia can cause the heart muscle to die from hypoxia, such as during a myocardial infarction. Chronic moderate ischemia causes contraction of the heart to weaken, known as myocardial hibernation. Coronary artery bypass surgery, also coronary artery bypass graft (CABG) surgery, and colloquially heart bypass or bypass surgery is a surgical procedure performed to relieve angina and reduce the risk of death from coronary artery disease. Arteries or veins from elsewhere in the patient's body are grafted to the coronary arteries to bypass atherosclerotic narrowing and improve the blood supply to the coronary circulation supplying the myocardium. Dr. René Favaloro, an Argentine surgeon, achieved a physiologic approach in the surgical management of coronary artery disease, the bypass grafting procedure, at the Cleveland Clinic in May 1967. His new technique used a saphenous vein autograft to replace a stenotic segment as a bypassing channel, which has become the typical bypass graft technique we know today. The terms single bypass, double bypass, triple bypass, quadruple bypass and quintuple bypass refer to the number of coronary arteries bypassed in the procedure. A coronary artery may be unsuitable for bypass grafting if it is small (< 1 mm or < 1.5 mm depending on surgeon preference), heavily calcified or intra myocardial. The 2004 ACC / AHA CABG guidelines state CABG is the preferred treatment for:

- Disease of the left main coronary artery (LMCA).
- Disease of all three coronary vessels (LAD, LCX and RCA).
- Diffuse disease not amenable to treatment with a PCI.

The 2005 ACC / AHA guidelines further state: CABG is likely the preferred treatment with other high – risk patients such as those with severe ventricular dysfunction or diabetes mellitus.

Prognosis following CABG depends on a variety of factors, but successful grafts typically last around 10 – 15 years. Age at the time of CABG is critical to the prognosis; younger patients with no complicating diseases have a high probability of greater longevity. The older patient can usually be expected to suffer further blockage of the coronary arteries. A graft is considered patent if there is flow through the graft without any significant (> 70% diameter) stenosis in the graft. Graft patency is dependent on a number of factors, including the type of graft used (internal thoracic artery, radial artery, or great saphenous vein); the size or the coronary artery that the graft is anastomoses with, and, of course, the skill of the surgeon(s) performing the procedure.

CABG can help to restore blood flow to an area of the heart. However, progression of atherosclerosis continues and patients and healthcare providers must work together after surgery to treat the underlying atherosclerosis and the factors that can cause progression of heart disease.

Post surgical rehabilitation needed to facilitate the patient to come back his / her ADLs. Cardiac rehabilitation is an important part of rehabilitation which can be described asthe combined and coordinated use of medical, psychosocial, educational, vocational and physical measures to facilitate return to an active and satisfying lifestyle. Enable patients to return to activities of daily living within the limits imposed by their disease. The goals of cardiac rehabilitation are to improve functional capacity, alleviate or lessen activity related symptoms, reduce disability and identify and modify coronary risk factors in an attempt to reduce subsequent morbidity and mortality due to cardiovascular illness. The ultimate goal off cardiac rehabilitation is to restore and maintain an individual's optimal physiological, psychological, social and vocational

status. Each individual's risk factors are assessed to develop a personal prevention plan. This strategy is practiced through group education classes, offered for patients and their family to educate cardiac risk factors and encourage them to adopt healthy lifestyle for primary and secondary prevention.

Cardiac Rehabilitation services are divided into 3 phases; **Phase 1 –** Initiated while the patient is still in the hospital. **Phase 2 –** A supervised ambulatory outpatient program; close telemetry monitored. **Phase 3 –** A lifetime maintenance phase in which physical fitness and additional risk – factor reductions are emphasized.

Exercise prescription depends on the results of exercise testing, which often includes cardiopulmonary exercise (CPX) testing. Three main components of an exercise training program are as follows:

Frequency – The minimum frequency for exercising to improve cardiovascular fitness is 3 times weekly. **Time –** Patients usually need to allow 30 – 60 minutes for each session, which includes a warm-up of at least 10 minutes. **Intensity –** The intensity prescribed is in relation to one's target heart rate. Aerobic conditioning is emphasized in the first few weeks of exercise. Strength training is introduced later.

The Borg scale of Rate of Perceived Exertion (RPE) is used. Patients usually should exercise at an RPE of 13 – 15.

The New York Heart Association Functional Classification **Class I.** Patients with cardiac disease but without resulting limitation of physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, dyspnea, or anginal pain. **Class II.** Patients with cardiac disease resulting in slight limitation of physical activity. They are comfortable at rest. Ordinary physical activity results in fatigue, palpitation, dyspnea, or anginal pain. **Class III.** Patients with cardiac disease resulting in marked limitation of physical activity. They are comfortable at rest. Less than ordinary activity causes fatigue, palpitation, dyspnea, or anginal pain. **Class IV.** Patients with cardiac disease resulting in inability to carry on any physical activity without discomfort. Symptoms of heart failure or the anginal syndrome may be present even at rest. If any physical activity is undertaken, discomfort is increased.

Literature Reviews

The ACC / AHA practice guideline for CABG recommends that CR should be offered to all eligible patients after CABG; it helps to decrease and modify risk factors and through modification in life style changes in diet and proper exercise is important for cardiac endurance. By exercise monitoring it helps in regaining the healthy life and is good for the patency of grafts (Eagle, et al., 2004).

Exercise testing is needed for all patients before initiation of a CR program (i.e., those with recent MI, recent CABG, recent coronary angioplasty, chronic stable angina, or uncontrolled heart failure). Exercise testing in CR is recommended for the development of the exercise prescription to establish a safe and effecttive training intensity, in risk stratification of patients to determine the level of supervision and monitoring required during exercise training sessions, and in evaluation of training program outcome (Gibbons, et al., 2002).

The prescribed activity level remains relatively low with Phase II CR. Exercise intensity is regulated by monitoring peak heart rate, which should not exceed the level achieved during the pre-discharge sub maximal exercise test. The exercise training modalities used during Phase II, as in Phase I, usually consist of walking and stationary bicycling. (Goroll and Mulley; 2007).

Phase II CR is described by the U.S. Public Health Service as consisting of "comprehensive, long term programs involving medical evaluation, prescribed exercise, cardiac risk factor modification, education, and counseling." These programs "are designed to limit the physiologic and psychological effects of cardiac illness, reduce the risk of sudden death or reinfarction, control cardiac symptoms, stabilize or reverse the atherosclerotic process, and enhance the psychosocial and vocational status of selected patients." CR programs aim to reduce subsequent cardiovascular related morbidity and mortality. Phase II CR refers to outpatient, medically supervised programs that provide electrocardiogram (ECG) monitoring. The programs are typically initiated within one to three weeks after hospital discharge and generally administered within the six months following discharge from the hospital (Centers for Medicare and Medicaid Services [CMS], 2006; Wenger, et al., 1995).

The ACC / AHA heart failure practice guideline for the evaluation and management of heart failure recommended that exercise training should be considered for all stable outpatients with chronic heart failure who are able to participate in the protocols needed to produce physical conditioning (Hunt, et al., 2005).

Cardiac rehabilitation improves the subjective condition of the patient. However to investigate whether there are associated structural and functional cardiac adaptations a study group of 39 patients with an inferior infarction and 21 patients with an anterior infarction, treated by surgical revascularization followed by4 months of cardiac rehabilitation were chosen. Performance capacity was significantlyimproved after cardiac rehabilitation that was maintained for 4 monthswith three 90-min sessions per week during the first 2 months, and 2 per week during the last 2 months, but left ventricularfunction remained unchanged on Doppler imaging. There were no statistically significant differencesin weight, body mass index, mean blood pressure, or cholesterol levels after the rehabilitation program. Patients with an inferiorinfarction exhibited improved strain values in the anteriorwall; those with an anterior infarction had improved strainvalues in the inferior wall. Strain imaging indicated that cardiac rehabilitation could bring about improvementsin cardiac function exclusively in the healthy non-infarcted myocardium, while there were signs of further deterioration of myocardial function in the highly ischemic zones. This study demonstrates that cardiac rehabilitation cannot induce structural or functional heart adaptations in patients with MI (Jan Claessens, et al., 2007).

Previous studies have demonstrated that CR improves exercise tolerance and muscle strength in patients with myocardial infarction (MI) and in patients after cardiac surgery. However, the association between exercise tolerance and muscular strength following CR and the comparison of relationships among various disease categories has not been fully examined. In this background, one hundred and four patients who participated in CR for 6 months were enrolled [post-cardiac valve surgery (VALVE), $n = 28$; post-coronary artery bypass grafting (CABG), $n = 42$; post-acute MI, $n = 34$]. The exercise tolerance, thigh / calf circumferences, and muscle strength were measured before and after CR. At the baseline, the thigh circumference was significantly smaller in the VALVE group than in the MI group. There were significant positive correlations between peak VO_2 and muscle torques of the lower muscles in all groups. After 6 months, peak $VO_2$and muscle torque were significantly increased in all groups ($p < 0.001$). A positive significant correlation between percent increases in peak $VO_2$and muscular strength was observed in the VALVE group ($r = 0.51$, $p < 0.01$), but not in the other groups. In addition, the changes in peak VO_2 and calf circumference after CR were significantly higher in the VALVE group than in the MI group. These data suggest that exercise intolerance in patients after heart valve surgery may in part depend on decreased muscular strength. Further studies are needed to assess whether the strategy of increasing muscular strength of lower limb by programmed resistance training could be effective for improving exercise intolerance in patients after heart valve surgery and symptomatic patients with heart failure. (Takahiro Sumide, et al., 2009).

Method and Material

50 patients (46 male, 4 female) were selected after informed consent through simple random sampling technique, had CABG in last 4 months with graft taken from the leg.Pre and post session evaluation and assessment of the patient was done and patient assessment level graded on the basis of scale (Manual Muscle Testing (MMT) and Rate Per Exertion) to understand the changes in fitness, cardiac endurance, physical activity, exertional levels and the extent of recovery of patient due to cardiac rehabilitation phase II. The participants were evaluated at session one and session eighteen of Phase II on BORG Scale for exertion and MMT for calf strength. All participants took 18 sessions of endurance training (treadmill and recumbent bike) on alternate days, 3 days a week. The collected data was analyzed by Wilcoxon Signed – Rank Test.

Inclusion Criteria

- Both male and female sex.
- CABG surgery performed during study duration.
- Good Progress in phase 1 in physical activity.
- Elective CABG procedure.
- Age between 45 – 65.
- Functional class 1 – 3.
- Saphenous vein graft from leg.

Exclusion Criteria

- Other than CABG like Mitral Valve replacement, Aortic Valve Replacement etc.
- Functional class more than 3.
- Cardiovascular instability or aneurysm.
- Emergency or urgent CABG.
- Patient with ARF, CRF and on Dialysis.
- Pulmonary surgery with CABG.
- Pacemaker or ICD implanted.
- Neurological co-morbid.

Results

Using Wilcoxon test on data, the result were found to be significant at $p > 0.01$ for one tail. This suggest that cardiac rehabilitation phase II program helps in strengthening of calf muscle had saphenous vein used in CABG.

Limitation of Study

Manual muscle testing was used to assess the strength of calf muscles; which is dependent upon the manual resistance applied and this can easily be varied from observer to observer. So the reliability of the tool is suspicious. Because of the non-availability of the Kendall Method, an EMG based muscle testing method, we limited to the manual muscle testing for our study.