International Journal of Health Sciences and Research
Vol.11; Issue: 2; February 2021
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

Comparative Study on Combined Effect of Aerobic Interval Training with Conventional Cardiac Rehabilitation Versus Conventional Cardiac Rehabilitation Alone in Improving the Endurance Capacity and Quality of Life after Coronary Revascularization (CABG)

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ABSTRACT

Objective: To find out and Compare the Combined effect of Aerobic interval training with Conventional cardiac rehabilitation over Conventional cardiac rehabilitation alone on endurance capacity and quality of life after Coronary Revascularization.

Background: Coronary artery disease commonly affects the coronary arteries of the heart. Various studies revealed that there is change in quality of life in CABG patients. Physiotherapy intervention needs to be targeted according to the postoperative complications like airway clearance techniques or strengthening the respiratory muscles, etc. Apart from conventional physiotherapy treatment, aiming to re-establish endurance capacity and quality of life, some strategies such as aerobic interval training should be used which will improve endurance capacity. This Present study is focused to determine whether the combined administration of Aerobic exercise training with conventional cardiac rehabilitation has more benefits in comparison with conventional cardiac rehabilitation

Methodology: A Pretest Posttest Experimental Design was used to conduct a 4 week duration interventional study. A total of 30 patients were selected based on the selection criteria and divided into two groups. Each group consisted of (n=15) members. The sample selection was done using random sampling method after due consideration of inclusion and exclusion criteria. Group A received both Aerobic exercise training and conventional cardiac rehabilitation and Group B receives only Conventional cardiac rehabilitation. Six minute walk test and MacNew Questionnaire were used as outcome measure for endurance capacity and quality of life respectively. The Effective training method is identified with appropriate statistical method.

Results: The comparison of post-test values of Six Minute Walk Test between Group – A and Group - B showed that the calculated 't' value 9.84 which is greater than the tabulated t value 2.048 at 5% level of significance. This shows that there is a significant improvement on Endurance Capacity in Group A than Group B following treatment. The comparison of post-test values of MacNew questionnaire between Group - A and Group - B showed that the calculated't' value 15.89 which is greater than the tabulated 't' value 2.048 at 5% level of significance. This shows that there is a significant improvement on Quality of Life in Group A than Group B following treatment.

Conclusion: This study concluded that aerobic interval training when added to conventional physiotherapy program proved to be significantly effective in improving endurance capacity and quality of life as compared to conventional cardiac rehabilitation alone after Coronary Revascularization.

Key words: Aerobic interval training, Conventional cardiac rehabilitation, Endurance capacity, Quality of life, Six minute walk test (6MWT), MacNew questionnaire.

INTRODUCTION

Coronary artery disease (Myocardial infarction (MI)) occurs when there is a diminished blood supply to the heart caused due to atherosclerosis and occlusion of an artery by an embolism which leads to irreversible necrosis and myocardial cell damage[1].

Type of coronary artery disease is been classified according to the area affected-

- Anterior wall (septal) MI- Obstruction of left anterior descending artery.
- Posterior / lateral wall MI- Obstruction of circumflex artery.
- Inferior wall MI- Obstruction of right coronary artery[2].

Coronary artery disease (CAD) is the main cause of death worldwide and society ranked as first cause of death in India and one of the leading cause of disability, cardiovascular disease is identified as either an acute or chronic cardiac disability resulting due to reduction or arrest of blood supply to myocardium with associated coronary arterial disease[3]. Nine million deaths were caused by CHD Worldwide. Men were more commonly affected than women, and incidence starts in the fourth decade of life. The current prevalence rate of 1,655 per 100,000 populations is expected to exceed 1,845 by 2030 [4].Chronic evaluation of blood pressure; blood lipid disorder, physical inactivity and decline in functional capacity remain the major modifiable risk factors for coronary artery disease [5].

The most common symptom of coronary artery disease is angina which described as feeling of heaviness, burning sensation and of fullness feeling. It is usually felt in the chest and may be felt in the left shoulder, arm or jaw. Other symptoms include shortness of breath, palpitation, weakness or dizziness, nausea and sweating[6]. Treatment of CAD involves making lifestyle changes, medications, possibly undergoing invasive/ surgical procedures[7].

Cardiac rehabilitation is long term program that involves prescribed exercise, education and counseling to limit psychological effects of cardiac disease and to enhance the psychosocial and vocational status of selected patients. Cardiac rehabilitation starts in the hospital, before discharge and also continues after discharge, in a supervised setting and transitions to a home based program to be continued indefinitely.

According to the literature available, exercise training forms the core component of cardiac rehabilitation in patient with coronary artery bypass graft (CABG) surgery and the positive effects have been studied extensively. Historically, the primary focus of most cardiac rehabilitation exercise programs has been aerobic activities.

However over the past decades strength (or resistance) program has been incorporated into rehabilitation programs[8].

In 2004, a systemic review and meta-analysis revealed that exercise-based cardiac rehabilitation reduced cardiac mortality and triglycerides level and systolic blood pressure. But there were no significant changes in high density lipoprotein cholesterol (HDL-C) and low density lipoprotein cholesterol (LDL-C) levels and diastolic blood pressure in coronary artery disease patients [9].

Early exercise training has shown to increase in an exercise based cardiac rehabilitation program after CABG[10]. Assessment of lung functions becomes an important factor post operatively. Also the intervention needs to be targeted according to the post-operative complications like air way clearance techniques or strengthening the respiratory muscles etc. [11]. Aerobic interval training reserves weakness and improves endurance.[12]

Literatures detailed that application of anesthesia combined with supine lying position results in an upward shift of the diaphragm, relaxation of the chest wall, altered chest wall compliance. All this factors results reduced respiratory muscle strength and significant lower post-operative endurance capacity[13]. Patients often suffer from psycho-emotional symptoms, such as depression, anxiety. The pain after surgery reduces endurance capacity results in poor quality of life in individuals who undergone CABG[14].

Assessment of quality of life using self- reported questionnaire is a way to evaluate and explore the psychological experience of patient with heart problems. The original version of the MacNew questionnaire is a diagnostic tool comprising multiple choice questions[15].
Patients are instructed to check only one out of seven possible answers. Each marked with a check box and is unable to select more than one answer for each proposed questions for computation of the final score. Global and subscale scores are computed by dividing the sum of the scores achieved for each individual item by the number of items listed in the questionnaire[15].

Six minute walk test (6MWT) has become one of the most popular clinical exercise tests for evaluating functional capacity. It is a practical and low cost test, that can be applied in different ages and body mass index and provide the exercise capacity of patients to perform routine activity or task. The 6MWT is a sub maximal exercise test for evaluating physical functional capacity. Suggest that 6MWT is feasible and well tolerated in adult and older patients, shortly after uncomplicated cardiac surgery and provides reference values for distance walked after cardiac surgery.[16, 17]

The distance that a patient can walk on a flat surface in a period of 6MWT may be used either as a generic one time measure of functional status or as an outcome measure for rehabilitation program. Assessment of functional capacity is an Integral part of the clinical management of in post CABG patient[16,17] .

Exercise therapy has long been used for rehabilitation purposes and benefit of regular physical exercise is also well established. The intensity of aerobic exercise training is a key issue in cardiac rehabilitation programs. Endurance Aerobic training is typically performed as continuous training at moderate to high exercise intensity in steady state conditions of aerobic energetic yield [18] .

However interval training has been proposed to be more effective than continuous exercise for improving exercise capacity. The interventions are often based on the deterioration of Aerobic capacity that results from the progressive hemodynamic consequences in myocardial infarction patients[19].

Improved accessory respiratory muscle function is the mechanism responsible for the increased endurance capacity observed in post CABG patient performing 6MWT[25].

The MacNew heart disease health related quality of life questionnaire is now available as a self administrated instrument[26]. The MacNew is designed to evaluate how daily activities, presented as physical limitation and emotional and social functioning sub scales and a global scales are affected by CAD and its treatment[27].The items and scales are scored from 1 (low HRQOL) TO 7 (High HRQOL) and minimal important difference on each MacNew scale is 0.50 points[15]. The reliability level of the English MacNew has been established to be an average between the fifth and sixth grade level.

For health promotions, patients with CAD are recommended to regular exercise at intensities ranging from 40-90% of VO2 peak.[23] However aerobic exercise training programs are most often carried out at low to moderate intensities.[23,24] Several studies have shown a significant inverse relationship between participation in rehabilitation program involving exercise and reduced progression of CAD.

Higher intensity of physical activity was related to reduced risk [21]. It is reflected by an inverse association between exercise intensity and coronary heart disease incidence in men[22].

Previously there was only limited information regarding the effect of Aerobic interval training after CABG surgery on endurance capacity and quality of life. However, study on influence of Aerobic interval training in individuals is very less. Hence, there was need to study out the efficacy of Aerobic interval training and conventional cardiac rehabilitation on endurance and quality of life after Coronary Revascularization.

OBJECTIVES

- To find out the combined effect of Aerobic interval training with Conventional cardiac rehabilitation on endurance capacity and quality of life after Coronary Revascularization.
- To find out the effect of Conventional cardiac rehabilitation on endurance capacity and quality of life after Coronary revascularization.
- To Compare the Combined effect of Aerobic interval training with Conventional cardiac rehabilitation over Conventional cardiac rehabilitation alone on endurance capacity and quality of life after Coronary Revascularization.

METHODOLOGY

STUDY DESIGN: Pre-test and Post-test experimental study design.

STUDY SETTING: The study was conducted in the Department of Cardio-Thoracic Surgery and Department of Physiotherapy, K.G. Hospital, Coimbatore.

STUDY DURATION: The study was conducted over a period of six months. Each patient underwent treatment for the duration of 4 weeks.

- Frequency: Five days / week.
- Duration: 30-40 minutes / session.

STUDY SAMPLES:

The sample size was determined based on a pilot study. Ten patients were divided randomly into two equal groups, and the main part of the study was conducted on them. The mean and standard deviation (SDs) for the parameters from this pilot study, with $\alpha = 0.05$ and 90% power, were used to calculate the sample size.

A total of 30 patients were selected based on the selection criteria and divided into two groups. Each group consisted of (n=15) members. The sample selection was done using random sampling method. The informed written consent was obtained from the patients after explaining the purpose and procedure of the study in the language they understood best.

CRITERIA FOR SELECTION

INCLUSION CRITERIA

- Age of 40-60 years
- Only males were included for the study.
- Only CABG patients were included.
- Patients with LVEF (left ventricular ejection fraction) >45 %
- Patients willing to do exercise.
- Patients were taken only from 7th post operative day.
- Patients referred to the study by cardiothoracic surgeon.

EXCLUSION CRITERIA

- Age below 40 and above 60.
- Females were excluded.
- Percutaneous transluminal coronary angioplasty patients.
- Complicated and readmitted to ICU
- Valvular diseases.
- Cardiomyopathy patients.
- Left ventricular dysfunction/ Pulmonary hypertension.
- Patients with renal problem.
- Patients with respiratory problems.
- Patients with lower limb injuries.
- Patients with any type of infections.

VARIABLES

INDEPENDENT VARIABLES

- Aerobic interval Training
- Conventional cardiac rehabilitation.

DEPENDENT VARIABLES

- Endurance Capacity
- Quality of Life

OPERATIONAL TOOLS

- Six Minute Walk Test
- MacNew Questionnaire

PROCEDURE

After coronary revascularization, patient was shifted from cardiac ICU to cardiac inpatient unit on third postoperative day. All the patients were assessed by cardiothoracic surgeons and stated to be haemodynamically stable and recommended for cardiac rehabilitation.

Based on the inclusion criteria and willingness of patients, the subjects were recruited for the study. Approximately 60 surgeries were done in the period of study. The patients were recruited with the prescription from the cardiac surgeon and a clear assessment was done to find the suitable participants in this study.

The patients were divided into 2 groups by simple random sampling method, each group consist of 15 patients after Coronary Revascularization. A clear instruction was given to all the patients who signed up for the study, written consent was obtained from every individual patient. Instruction about the exercises, beneficial effect of the exercises, demerits of exercises were told to the patients, log book use was instructed to the patient and invited them to visit the OPD (physiotherapy department) during their next visit with the doctor.

Six minute walk test was instructed and asked them to perform in the hospital corridor with the markings over the floor and MacNew questionnaire was given to them and asked to fill-up the questionnaire, some assistance was provided by the team of physiotherapy during the questionnaire fill-up. The collected data were kept confidentially and taken for the analysis.

GROUP- A

- Patients in this group underwent Aerobic interval training (Trine T. Moholdt 2009)
- The aerobic interval training program consisted of treadmill walking. Aerobic interval training consist of 8 minutes of warm up, followed by 4 times of 4 minute intervals with heart rate at 90% of maximum heart rate, with active pause of 3 minutes of walking at 70% of maximum heart rate.
- The exercise session was terminated by 5 minute cool down period.
- The intensities were controlled by heart rate monitor (Polar elctro, kempele, Finland).

In addition to Aerobic Interval Training, Patients in this group underwent Conventional Cardiac rehabilitation (Renu B. Pattanshetty 2014),

- Diaphragmatic breathing exercise
- Upper and Lower Limb Exercises
- Stair climbing Activities

METS	CARDIAC REHABILITATION EXERCISES	ACTIVITY
1 - 1.5 (LEVEL 1)	Sitting with feet supported. Active assisted range of motion exercises to major muscle groups of upper limbs. Active ankle exercises. Active scapular elevation and depression. Frequency of 3-5 repetitions for all exercises, once a day. Deep breathing exercises like diaphragmatic, pursed lip breathing, thoracic expansion exercises. Incentive Spirometry exercises Breathing exercises every two to three hourly - 10 Repetitions	Begin sitting in chair with support several times per day for 10-30 minutes. Monitored ambulation 100-200 feet with assistance, once or twice daily.
1.5 – 2 (LEVEL 2)	Active range of motion exercises to major muscle groups of upper limbs. Active ankle and knee exercises. Active scapular elevation and depression. Frequency increased to 5-10 repetitions, twice a day. Breathing exercises same as above.	Same as above. Increase ambulation to 300feet or Approximately 3 corridor lengths at a slow pace with assistance and slowly progress

Table Continued		
2 - 2.5 (LEVEL 3)	Active range of motion exercises to major muscle groups of upper limbs. Active ankle and knee exercises. Active scapular elevation and depression. Standing leg exercises optional Breathing exercises same as above. Frequency increased to 15 repetitions, twice a day	Room or hall ambulation up to 5-10 min as tolerated 3-4 times/day (424-848 feet). Bathroom/privileges Independent/assisted ambulation in room or hall as advised by The Physiotherapist (PT)
2.5 – 3 (LEVEL 4)	Same as above. Standing trunk exercises optional	Hall ambulation up to 10- 15 min as tolerated 3-4 times/day (3000 feet
3 – 4 (LEVEL 5)	All exercises same as above	Hall ambulation increased as tolerated by the patient
4 – 5 (LEVEL 6)	All exercises same as above. Home exercise program explained	Progressive-hall ambulation as tolerated by the patient. Full flight of stairs – once up and down with one step at a time.

GROUP- B

Patients in this group underwent only Conventional Cardiac rehabilitation program (Renu B. Pattanshetty 2014)

STATISTICS

The Paired 't' test was used to compare the pre and post test values within Group A & Group B. The unpaired 't' test was used to compare the post test values between Group - A and Group -

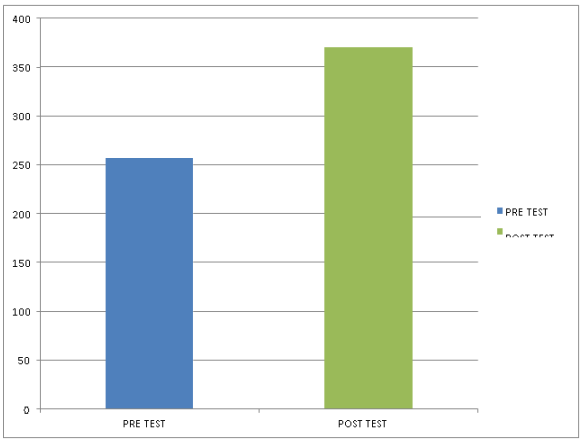


Table-I: Group – A (aerobic interval training with conventional cardiac rehabilitation) six minutes walk test paired't' test

S.No	TEST	MEAN	MEAN DIFFRENCE	STANDARD DEVIATION	't' VALUE
1.	PRE-TEST	256.46			
2.	POST-TEST	370.33	113.87	5.802	19.62

Table- II Group – B (conventional cardiac rehabilitation) six minute walk test paired 't' test

S.NO	TEST	MEAN	MEAN DIFFRENCE	STANDARD DEVIATION	't' VALUE
1.	PRE-TEST	250.86			
2.	POST-TEST	307.93	57.07	3.481	16.39

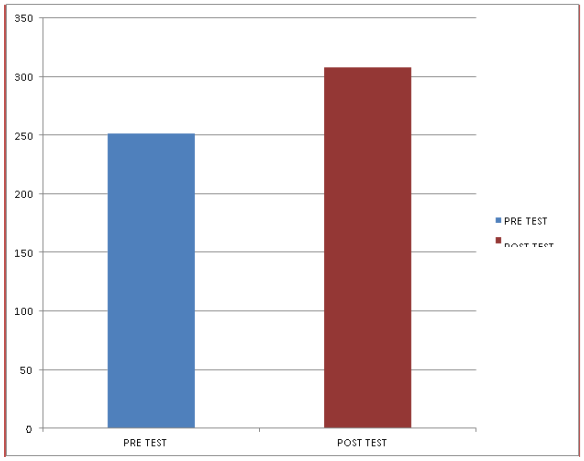


Table- III Group - A vs Group - B six minute walk test unpaired't' test

S.NO	TEST	MEAN	MEAN DIFFRENCE	STANDARD DEVIATION	't' VALUE
1.	GROUP - A	307.93			
2.	GROUP - B	370.33	62.4	6.33	9.84

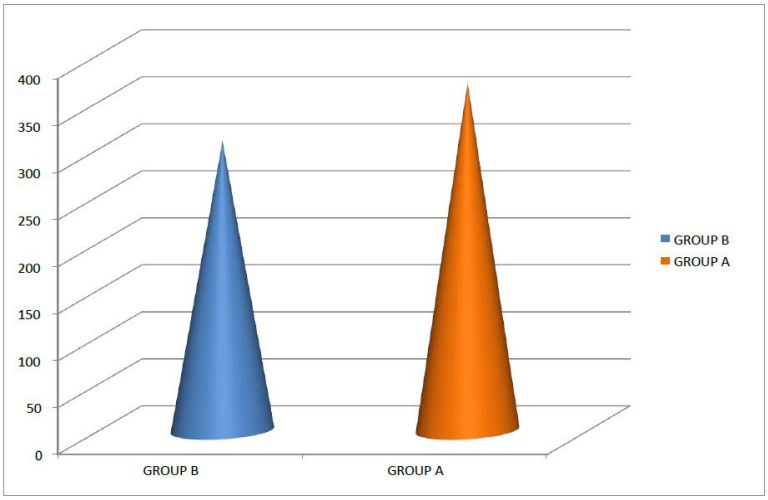


Table-IV: Group - A-aerobic interval training with conventional cardiac rehabilitation macnew questionnaire paired‘t’ test

S.NO	TEST	MEAN	MEAN DIFFRENCE	STANDARD DEVIATION	't' VALUE
1.	PRE - TEST	35.2			
2.	POST-TEST	167.3	132.1	1.47	89.79

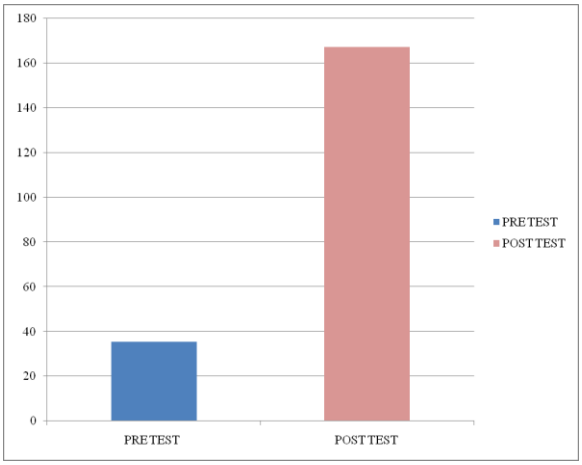


Table-v:Group –B- conventional cardiac rehabilitation macnew questionnaire paired‘t’ test

S.NO	TEST	MEAN	MEAN DIFFRENCE	STANDARD DEVIATION	't' VALUE
1.	PRE -TEST	34.4			
2.	POST-TEST	138.13	103.73	1.5	66.89

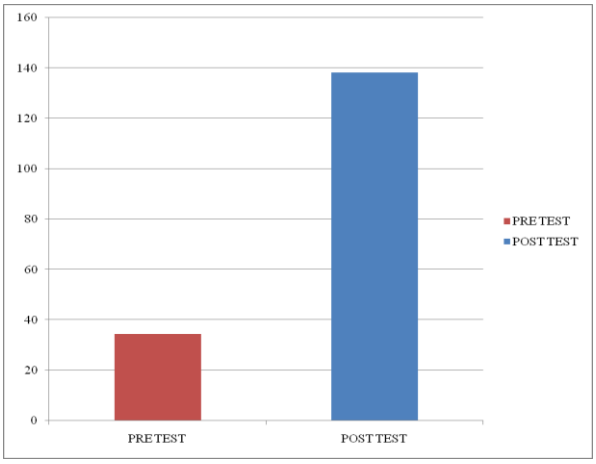
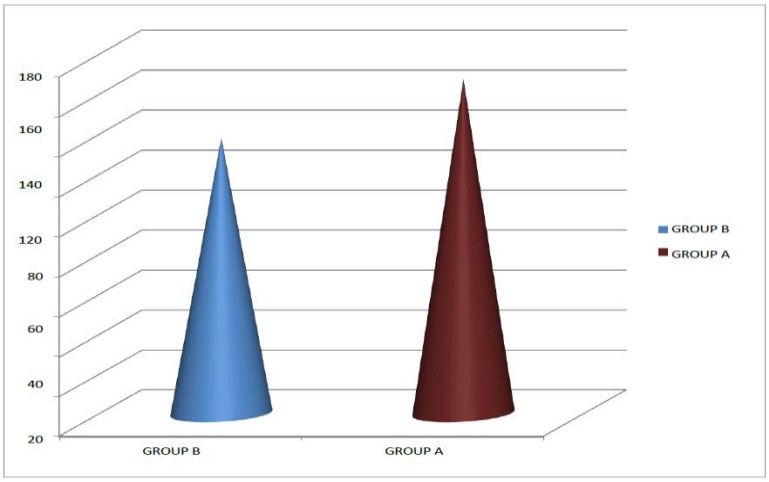


Table- VI group - a vs group – b macnew questionnaire unpaired‘t’ test

S.NO	TEST	MEAN	MEAN DIFFRENCE	STANDARD DEVIATION	't' VALUE
1.	GROUP - A	138.13			
2.	GROUP - B	167.3	29.17	1.83	15.89



RESULTS

Both the groups show significant differences from pre test to post test values. The 't' value for the Group - A is 19.62 and the 't' value for the Group - B is 16.39.

The comparison of post-test values of Six Minute Walk Test between Group – A and Group - B showed that the calculated‘t’ value 9.84 is significantly greater than the tabulated t value 2.048 at 5% level of significance. This shows that there is a significant improvement on Endurance Capacity in Group A than Group B following treatment.

Both the groups show significant differences from pre test and post test values. The 't' value for the Group A is 89.79 the ‘t’ value for the Group B is 66.89.

The comparison of pre-test and post-test values of MacNew Questionnaire between Group – A and Group B showed that the calculated ‘t’ value is 89.79 is significantly greater than the tabulated ‘t’ value 2.145 at 5% level of significance. This shows that there is a significant improvement in Quality of Life in Group A than Group B following treatment.

The statistical analysis revealed that there was statistically significant improvement in the endurance capacity and health related quality of life in both the groups, but there is a significant improvement in the endurance capacity and quality of life in the Group - A than Group – B.

DISCUSSION

Factors like anaesthesia, median sternotomy incisions, prolonged immobilization, insertion of thoracic and mediastinal drainage tubes makes patients presenting a restrictive disturbance with reductions in the pulmonary volumes, pressures and capacities. Therefore, cardiac rehabilitation should be focused on restoring the pulmonary function as early as possible and improve overall functional and psychological status of the patient. Cardiac rehabilitation program is prescribed to avoid inactivity and to maintain and improve pulmonary capacities and muscular strength especially in patients after cardiac surgery.

It was well accepted from the systematic review that patients who have undergone cardiothoracic surgery definitely need special attention directed towards the ventilatory function.

The variability in pain relief in post-operative patients is been influenced by their perception of pain. Patients may underestimate their pain due to their knowledge that it is natural to have pain after any surgical procedure despite which pain builds in character and plays a purposeful role in recovery.

Aerobic interval training has been demonstrated to activate p38 mitrogen-activated protein kinase and 5'-adenosine monophosphate-activated protein kinase. Exercise responsive signaling kinases are implicated in direct phosphorylation and activation of PGC-1α. Increased nuclear

abundance of PGC-α following interval training may co activate transcription factors to increase mitochondrial gene transcription, ultimately resulting in accumulation of more mitochondrial proteins to drive mitochondrial biogenesis. Mitochondrial biogenesis is essential to maintain the structural integrity of skeletal muscle. Mitochondrial function is associated with aerobic physical fitness and plays an important pathophysiological role in cardiac patients.

It is important to mention that the respiratory physiotherapy promotes recovery of lung function after cardiac surgery, since it leads to increased alveolar recruitment, increase in FRC and improves the diffusion capacity. [28]

Diaphragmatic breathing exercise are easy to perform, it helps to increased oxygenation immediately after 2nd post operative day of cardiac surgery. [29] Changes in muscle activity of diaphragm were shown to improve respiratory ability because of its synergy effect while these two muscles are doing inhalation.[30]

The high-intensity exercise in the AIT group was set to 90% of Hfmax and was performed as AIT because this training method has previously yielded the greatest improvements in aerobic capacity over a relatively short time in healthy individuals, and in patients with coronary artery disease, intermittent claudication the metabolic syndrome and post-infarction heart failure. The rationale behind interval training is that most evidence suggests that it is the pumping capacity of the heart (i.e. stroke volume) that limits, Vo2max, and the interval design allows for rest periods that make it possible for the adolescents to complete short work periods at higher intensities, which thereby challenge the heart's pumping ability more than what would be possible by continuous exercise.[31]

This study concludes that Aerobic interval training when added to conventional cardiac rehabilitation proved to be significantly effective in increasing the endurance capacity, thereby improving quality of life in patients who underwent median sternotomy for Coronary Revascularization procedure.

CONCLUSION

So this study concludes that aerobic interval training when added to conventional physiotherapy program proved to be significantly effective in improving endurance capacity and quality of life as compared to conventional cardiac rehabilitation alone after Coronary Revascularization.

Limitations

- Small sample size and study duration.
- Only males were included.
- In this caloric expenditure was not measured.
- Only patients after coronary revascularization were taken.

Recommendations

- A Similar study with Respiratory muscle strength as outcome can be conducted
- A Similar study with the measurements of caloric expenditure can be conducted.
- Different parameters can be included for further studies regarding aerobic interval training such as VO2 max with Borg scale.
- A Similar study with SF-36 as quality of life outcome can be conducted.

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How to cite this article: Menon R, Ramakrishnan V. Comparative study on combined effect of aerobic interval training with conventional cardiac rehabilitation versus conventional cardiac rehabilitation alone in improving the endurance capacity and quality of life after coronary revascularization (CABG). *Int J Health Sci Res.* 2021; 11(2): 220-230.

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