Original Article

EFFECTIVENESS OF LOW INTENSITY EXERCISES ON SIX MINUTE WALK DISTANCE AND HAEMODYNAMIC VARIABLES IN CABG AND VALVE REPLACEMENT PATIENTS DURING PHASE 1 CARDIAC REHABILITATION IN A TERTIARY CARE SETUP: A COMPARATIVE STUDY

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ABSTRACT

BACKGROUND AND OBJECTIVES: Cardiovascular diseases are common and devastating health problem in India. The most common is the coronary artery diseases and heart valve diseases. Cardiac rehabilitation programme is an essential, useful and safe part of the care for patients with cardiovascular disease. The present study was under taken to compare the effectiveness of low level intensity exercises on haemodynamic variables and functional capacity in subjects enrolled in phase 1 cardiac rehabilitation.

MATERIAL AND METHODS: Thirty (30) adult subjects both male and female comprising of CABG (15 subjects) and valve replacement (15 subjects) were included. Low intensity exercises were given to both groups which included range of motion exercises, stretching and minimal strength training. Haemodynamic variables and six minute walk distance were assessed pre and post invention in all the subjects.

RESULTS: The study demonstrated BMI to be lower valve replacement group than CABG group (p = 0.008). Ejection fraction(%) were higher in valve replacement subjects compared to CABG subjects (p = 0.027). Significant mean differences were noted in the heart rate between both the groups. (p = 0.045). There was a significant improvement in the six minute walk distance (p = 0.048) in both groups.

CONCLUSION: Low intensity exercises demonstrated improvements in heart rate and functional capacity in subjects with CABG and valve replacement in phase I cardiac rehabilitation.

KEYWORDS: Phase 1 Cardiac rehabilitation, Coronary artery bypass grafting, Valve replacement, Blood pressure, Mean arterial pressure, Pulse pressure, Rate pressure product and Six minute walk distance.

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INTRODUCTION

Cardiovascular diseases are a common and devastating health problem in Indian society. Ranked as the first cause of death in India and one of the leading causes of disability,[1] cardiovascular disease is identified as either an acute or chronic cardiac disability resulting from a reduction or arrest of blood supply to the myocardium with associated coronary arterial disease.[2] In 2000, there was a nearly 3% overall prevalence of coronary heart disease in India. In the year 2002 coronary heart disease was the leading cause of death in India, leading to 1.46 million deaths (14% out of a total of 10.3 million deaths). [3]

Diseases of the heart valves include a diverse group of acquired and congenital lesions. These

diseases are common with an estimated prevalence of 2.5% in the Western world.[4] Some of these occur in isolation and others occur in association with the other heart diseases. In India, the prevalence of rheumatic fever/rheumatic heart disease among the school children is 2-11 per 1000 with a mean of 6 per thousand.[5] The adult average ranges between 123 and 200 per 1,00,000 population.[6] when compared to the industrialized nations where the prevalence is less than 0.05/1000.[7]

The most common symptom of coronary artery disease is Angina which described as a heaviness, pressure, aching, burning, numbness, fullness, squeezing or painful feeling. It is usually felt in the chest and may be felt in the left shoulder, arms, neck, back, or jaw. Other symptoms include shortness of breath, palpitations, weakness or dizziness, nausea, sweating.[8]

Valvular heart diseases mainly resulting from the rheumatic fever significantly includes mitral stenosis or aortic stenosis moderate or severe mitral regurgitation, moderate or severe aortic regurgitation, and moderate or severe tricuspid regurgitation.[9] Symptoms of valve diseases include shortness of breath, weakness or dizziness, discomfort in chest, palpitations, swelling of ankles, feet or abdomen, and fever (with bacterial endocarditis). Three goals of treatment for heart valve disease include protecting valve from further damage, lessening symptoms and repairing or replacing valves. Rheumatic heart disease and infective endocarditis are important factors towards occurrence of valvular heart disease.[10]

Treatment for coronary artery disease (CAD) involves making lifestyle changes, medications, possibly undergoing invasive and/or surgical procedures. Valve replacement surgeries are done to replace the diseased valves of the heart by an artificial valve or a bio prosthetic valve. Bio prosthetic valve created from bovine or porcine valves or other animal tissue are strong and flexible and has shown to last 10-20 years and usually does not require the long-term use of medication. Artificial valves are made of strong durable materials which are long-lasting and require a blood thinning medication throughout the life which will prevent formation of clots.[10]

Cardiac rehabilitation (CR) is a long term program that involves prescribed exercise, education, and counseling to limit physiological and psychological effects of cardiac disease and to enhance the psychosocial and vocational status of selected patients. CR starts in the hospital, before discharge, continues after discharge, in a supervised setting and transitions to a home based program to be continued indefinitely.[11]

According to the literature available, exercise training forms the core component of cardiac rehabilitation in patients with coronary artery bypass surgery and the positive effects have been studied extensively.[12] Relatively less information is available concerning the results of low intensity exercise training in patients with valvular heart disease post-surgery. Some studies have concluded that a consistent increase in exercise capacity ranged from 25% to 38% was demonstrated without any serious risks in patients with valve replacement surgeries.[13] However, there is dearth of literature to show the effect of low intensity exercises on haemodynamic variables in valve replacement surgery patients in phase 1 cardiac rehabilitation. Hence, the present study aimed to compare the effectiveness of low level intensity exercises on haemodynamic variables and on six minute walk distance in phase 1cardiac rehabilitation on CABG and valve replacement surgery patients.

METHODOLOGY

Participants:

All post operative valve replacement and CABG subjects haemo-dynamically and mentally stable enrolled in phase I cardiac rehabilitation were included in the study. The data was collected from the post operative cardiac general ward from an Indian tertiary care set up during the study period extending for three months. Subjects were excluded if they fell in the high risk category (American College of Sports Medicine risk stratification guidelines[14]), conditions that were contraindicated to exercise training (American College of Sports Medicine guidelines[14]) and with drains. Ethical approval for the study was granted by the Institutional Ethical Committee and the procedures were conducted according to the declaration of Helsinki.

Study design:

The study was a pre post experimental design with random selection of valve replacement subjects using anon probability sampling method. Sample size was calculated with error of 80 and level of significance of p ≤0.05 and assuming fall out rate of 10% of subjects in both the groups.

Procedure:

All subjects in both the groups were initially examined for compliance with inclusion and exclusion criteria. Demographic and baseline data of outcome variables each subject was recorded. Subjects were then given a set of low intensity exercises. Haemo-dynamic variables and 6 minute walk distance of each subject was again recorded at the day of discharge. Exercise protocol[15]

Step 1: Ward treatment

· Active assistive to active range of motion (ROM) to major muscle groups, 3- 5 repetitions.

· Incentive spirometry in the form of deep breathing exercises.[16]

· Monitored ambulation of 100ft as tolerated. Ward Treatment (p.m.): In Sitting with feet supported

· Active ROM to major muscle groups, 5 repetitions.

· Incentive spirometry in the form of deep breathing exercises.

· Monitored ambulation of 100- 200ft with assistance as tolerated.

Step 2: Ward treatment: In Sitting

· Repeat exercises from step 1 and increase repetitions to 5- 10.

· Incentive spirometry in the form of deep breathing exercises twice daily.

· Monitored ambulation of 200ft as tolerated twice daily.

Step 3: Ward treatment: In standing

· Active upper limb and trunk exercises bilaterally without resistance; ankle exercises 5- 10 repetitions twice daily.

· Monitored ambulation 300ft twice daily or as tolerated.

Step 4: Ward treatment: In standing

· Active exercises from Step 3, 10- 15 repetitions, twice daily.

· Monitored ambulation of 424ft twice daily or as tolerated.

Step 5: Ward treatment: In standing

· Active exercises from Step 3, 15 repetitions, once daily.

· Monitored ambulation for 5- 10 minutes as tolerated (424- 848ft).

· Walk to the Exercise Cardiac rehabilitation centre (CRC) for monitored ROM / strengthening exercises from Step 3, 15 repetition;

· Stretching of hamstrings and gastrocnemius 10 repetitions.[17]

Step 6: Ward treatment: In standing

· Active exercises from Step 3 with minimal weight each upper extremity, 15 repetitions, once daily;

· Monitored ambulation for 10- 15 minutes or as tolerated.

CRC:

· Walk to the CRC for monitored ROM / strengthening exercises from Step 5 with minimal weight each upper extremity, 15 repetition;

· Stretching of hamstrings and gastrocnemius 10 repetitions;

Step 7: Ward Treatment: In standing

· Active exercises from Step 3 with minimal weight each upper extremity, 15 repetitions, once daily;

· Monitored ambulation for 15- 20 minutes or as tolerated.

CRC

· Walk to the CRC for monitored ROM\ strengthening exercises from Step 5 with minimal weight each upper extremity, 15 repetition;

· Stretching of hamstrings and gastrocnemius 10 repetitions.

Repetitions and walking distance were increased as per subject's tolerance till their discharge.

Fig. 1: Consort Flow Study Chart.
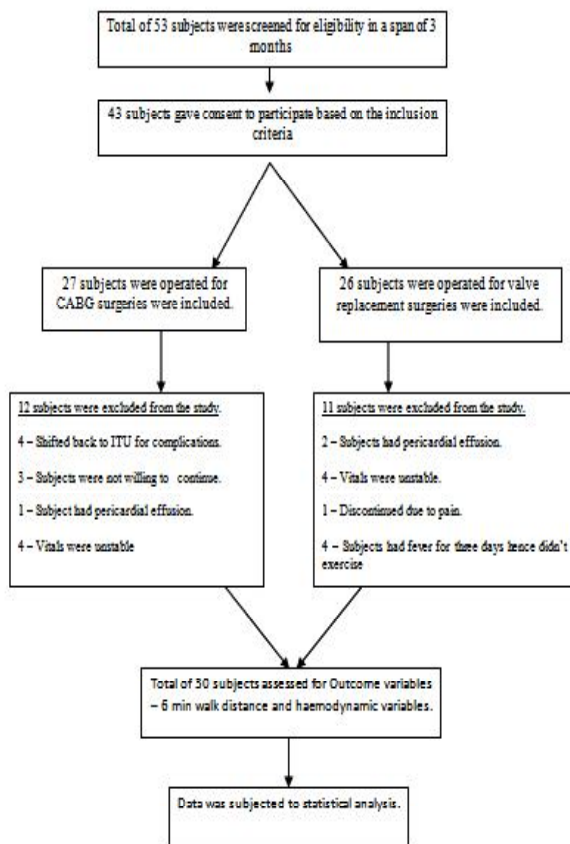
MEASUREMENTS OF OUTCOME VARIABLES [18]

Haemodynamic variables were measured as per the ACSM guidelines.

· Pulse pressure: It was calculated by using the systolic blood pressure (SBP) and diastolic blood pressure by using the formulae- PP = SBP – DBP

· Mean Arterial Pressure: It is described as an average blood pressure of an individual; at normal resting heart rates. MAP was calculated using formula -MAP= DBP +1/3 (SBP – DBP)

· Heart Rate: was done by palpation method .

Rate pressure product: The Rate Pressure Product was calculated using the

Formula - RPP= HR. SBP. 10^{-2}

· Six minute walk Distance (SMWD was carried out as per ATS guidelines.[19]

RESULTS

The result of the present study was analysed for functional capacity and haemodynamic variables. Intra and inter group differences were compared so as to evaluate the effectiveness of low intensity exercises protocol under consideration in the present study.

Table 1: Demographic and baseline characteristics of outcome variables in valve replacement (VR) and CABG groups.

S. no	Variables	VR group (n=15)	CABG group (n=15)	't'	'p' value
1	Age	40.3 ± 14.06	58.8 ±8.11	4.421	< 0.001
2	Gender (F:M)	6:09	12:03		
3	BMI	20.3 ± 4.51	24.2 ±2.65	2.9	0.008
4	Duration of Intervention (in days)	5.0 ±1.68	4.2 ±0.77	2.51	0.021
5	Ejection fraction(%)	59.33 ±2.58	55.33 ±6.11	2.3343	0.027
6	Systolic blood pressure(SBP)	115.6 ±13.27	121.3 ±14.07	1.148	0.261
7	Diastolic blood pressure (DBP)	70.8 ±13.66	75.3 ±11.87	0.97	0.34
8	Heart rate (HR)bpm	86.4 ±8.21	89.3 ±7.11	1.045	0.305
9	Rate pressure product (RPP)	100.5 ±19.49	108.4 ±15.23	1.23	0.229
10	Mean arterial pressure(MAP)	85.7 ±12.81	90.6 ±12.29	1.078	0.29
11	Pulse pressure(PP)	44.8 ±9.15	46.6 ±7.23	0.619	0.541
12	Six minute walk distance (meters)	102 ±33.63	96.6 ±35.79	0.421	0.677

Level of significance p ≤ 0.05

Table 2: Mean values of outcome variables post intervention in valve replacement (VR) and CABG groups.

S. no	Variables	VR group (n=15)	CABG group (n=15)	't'	'p'
1	Systolic blood pressure(SBP)	120.8 ± 6.49	120.1 ±5.20	0.31	0.759
	Mean difference (between pre post intervention)	+ 3.8 ±15.62	- 1.7 ±11.07	1.024	0.314
2	Diastolic blood pressure (DBP)	78.6 ±4.04	77.3 ±4.57	0.845	0.405
	Mean difference (between pre post intervention)	7.8 ±12.17	2 ± 9.41	1.476	0.151
3	Heart rate (HR)bpm	80.5 ±4.88	85.2 ±5.22	2.527	0.017
	Mean difference (between pre post intervention)	- 7.2 ± 6.23	-3.1 ±4.39	2.098	0.045
4	Rate pressure product (RPP)	96.8 ±8.41	101.69	1.641	0.112
	Mean difference (between pre post intervention)	- 3.7 ±21.16	-6.7 ±10.53	0.493	0.626
5	Mean arterial pressure(MAP)	92.7 ± 2.89	91.6 ±4.34	0.82	0.42
	Mean difference (between pre post intervention)	7 ±12.27	-0.95 ±9.69	1.499	0.145
6	Pulse pressure(PP)	42.1 ±8.50	42.8 ±4.32	0.271	0.789
	Mean difference (between pre post intervention)	- 2.7 ±10.49	- 4.4 ±6.15	0.552	0.565
7	Six minute walk distance (meters)	148 ±28.83	130.6 ±27.11	1.696	0.101
	Mean difference (between pre post intervention)	46 ±25.85	26 ±27.20	2.064	0.048

Level of significance p ≤ 0.05

STATISTICAL ANALYSIS:

Statistical analysis was done manually as well as using the statistic software SPSS 16.0 version so

as to verify the results obtained. The data was entered in an excel spread sheet, tabulated and subjected to statistical analysis. Various statistical measures such as mean, standard deviation and test of significance such as student paired 't' test and Fisher Exact test was utilized for all the available scores. Nominal data of the subjects like demographic data i.e. age, BMI, gender distribution and number of days of intervention were analysed using the 't' test. Inter group comparison of the pre interventional and the post interventional outcome measures was done using the students paired 't' test whereas Fisher Exact test was used to measure the intra group difference. Probability values less than or equal to 0.05($p \leq 0.05$) were considered statistically significant.

DISCUSSION

The present study aimed to compare the effectiveness of low intensity exercises on six minute walk distance and haemodynamic variables in CABG and valve replacement subjects during phase 1 cardiac rehabilitation. The study undertaken included a total of thirty (30) subjects out of which fifteen (15) were CABG group, and fifteen (15) in valve replacement group. Although many treatment methods are currently in practice to improve the haemo dynamic variables and the functional capacity of the subjects after heart surgery, the present study was an application of low intensity exercise program to achieve the above mentioned objectives.

The risk of coronary artery disease has shown to increase with higher age in CABG subjects and is comparatively lower in valve replacement subjects in the present study which was statistically significant. Age has shown to be an independent risk factor in CABG ranging from $\geq$ 75 years irrespective of their gender.[20] However, in the present study the age group ranges from 58.8 ± 8.11 years in CABG subjects. The age group in valve replacement subjects was lower (40.3 ± 14.06 years) which is comparable to the study conducted by Newell et al.[21] The cause for the valvular lesions were rheumatic heart disease in present study. However, no history of congenital cause or infective endocarditis was recorded.

BMI has shown to be an independent risk factor for coronary heart disease.[14] In India, coronary artery disease has not only become exceedingly common but tends to occur at a younger age also.[22] Categorizing BMI into different weight classes can have an impact on the assessment of relationship between BMI and in hospital mortality after CABG.[23] However, the present study showed a higher BMI in CABG but did not show any adverse outcome after CABG in terms of mortality. No categorization of BMI into different weight class was done in the present study since the sample size was small. A systematic review conducted to find out association of body weight and total mortality with cardiovascular events demonstrated that the total mortality in over weight and mildly obese group could not be explained only by BMI.[24] There may be some other confounding factors related to mortality in such patients. Combined influences of BMI and waist circumference have also shown to be a risk factor for coronary artery disease among children and adolescents.[25] However, the present study consisted of only adult age group and waist circumference may be considered in future studies.

Ejection fraction defined as the amount of blood pumped by the left ventricle into the aorta per minute has a normal value of 40 – 60%. In the present study, ejection fraction has shown to be significantly higher in valve replacement subjects as compared to CABG subjects. In a multi-centric prospective study by Meurin et al, early exercise training has shown to increase the ejection fraction in the valve replacement patients.[26] Ejection fraction has also shown to increased in an exercise based cardiac rehabilitation program after CABG.[12] Phase 1 cardiac rehabilitation has shown to improve the haemodynamic variables like ejection fraction in the subjects who underwent CABG and valve replacement surgeries.[27]

Cardiac rehabilitation after the CABG has shown to improve the heart rate recovery over one minute after exercise.[28] A positive effect in terms of heart rate recovery was noted in subjects who undertook cardiac rehabilitation program compared to those who did the home exercise program.[29] The present study has demonstrated that a set of low intensity exercises caused faster

heart rate recovery in both groups with faster improvement in CABG group than in valve replacement group. A set of aerobic and resistant training in cardiac rehabilitation has shown to improve haemodynamic responses in terms of maximum and resting systolic BP, maximum diastolic BP, ejection fraction, rate pressure product of the CABG subjects.[12] Also the right ventricular functions have shown improvement in CABG subjects after enrolling in the cardiac rehabilitation programmes.[30]

Self-exercise programmes have shown to improve the cardio-respiratory functions after heart surgeries.[31] Early exercise training after mitral valve repair has also shown to improve the outcome measures.[32] A controlled trial demonstrated that physical training after heart valve replacement showed consistent improvement in the cardio-respiratory fitness in the subjects including haemo-dynamic variables and functional capacity.[21]

Six minute walk distance is used to measure the exercise tolerance, effect of the therapy and the prognosis of the subjects. Walking distance in congestive heart failure subjects significantly improved after thirty two sessions of high intensity aerobic training.[33] Resistance training has shown to improve the muscle strength as well as the functional capacity.[34] Six minute walk distance has demonstrated significant improvement in submaximal exercise capacity following twelve weeks of exercise training in subjects with heart failure.[35] Combined aerobic and strength training has shown positive effect on walking performance and exercise tolerance after CABG.[36,37,38] Canadian Air force exercises demonstrated improvements in cardio respiratory fitness in heart valve surgery subjects.[21] Combined effects of aerobics and resistance training have also shown beneficial effects in cardiac rehabilitation subjects after CABG and congestive heart failure. However, in the present study there was no congestive heart failure subject enrolled. It should be noted that heart becomes stronger as a result of exercise. Therefore, it can pump more blood through the body with every beat which in turn keeps the blood vessel flexible, ensures proper blood flow and delivers oxygen to cardiac and skeletal muscles. Finally, it strengthens muscles and

increases work capacity, [12] the findings of which are similar in present study. Six minute walk test is a valid, reliable and responsive test in an in-patient and out-patient cardiac rehabilitation.[39] Cardiac rehabilitation programme using aerobics and resistance training has shown significant effects on haemodynamic responses such as resting and maximum systolic BP, resting and maximum diastolic BP, resting and maximum heart rate, ejection fraction and rate pressure product.[12] With six months of exercise training, resting heart rate has shown to decrease but maximum heart rate and left ventricular ejection fraction increase in the exercise training group, while the blood pressure was found to decrease.[12] Some studies revealed vigorous exercises to reduce systolic BP for more than 12 hours.[40] Since present study was conducted in Phase 1 cardiac rehabilitation, effects of low intensity exercises on haemodynamic variables though changed slightly did not demonstrate statistically significant values. The present study has also demonstrated to be safe since no adverse outcomes were noted. O'Farrell et al. demonstrated that systolic BP and Diastolic BP decreased in both gender.[41] No changes have been noted in the values of heart rate, systolic BP, diastolic BP, and rate pressure product among congestive heart failure subjects after cardiac rehabilitation program results of which are similar to the results of present study.[42]

To conclude, the present study has demonstrated that the regular low intensity training develops submaximal work tolerance which is through lessening contractility, reducing cardiac work, and myocardial oxygen demand.[43,44] In addition, it enhances the response of the haemodynamic variables such as heart rate which is clinically significant along with an improvement in the functional capacity tested through six minute walk distance. Physiologically, low intensity exercise training protocol involves large muscle groups which produces cardiovascular adaptation and improves myocardial perfusion by reducing endothelial dysfunction hence dilating the coronary vessels leading to increase exercise tolerance (capacity), endurance and skeletal muscle strength which may be evaluated by six minute walk distance.[43, 45,46]

Though the present study consisted of small sample size and a heterogeneous group, it demonstrated that low intensity exercises may be used to improve the heart rate as well as the functional capacity of the subjects after a heart valve replacement surgery and a CABG surgery falling in low and moderate risk category. In addition, the results also showed that the age and BMI are also risk factors for the CAD. Future studies should include larger sample size, with longer follow up period to assess the long term benefits in other phases, homogenous group to find out gender differences in the outcome measures and multi-centric trials of a similar set up.

CLINICAL MESSAGE:

Low intensity exercises may be used in low to moderate risk subjects of CABG and valve replacement subjects enrolled in phase I rehabilitation in improving their functional capacity.

Conflicts of interest: None

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