International Journal of Yoga, Physiotherapy and Physical Education
ISSN: 2456-5067; Impact Factor: RJIF 5.24
Received: 23-03-2020; Accepted: 26-03-2020; Published: 06-04-2020
www.sportsjournal.in
Volume 5; Issue 2; 2020; Page No. 01-04

To compare effect of concentric resistive and eccentric resistive exercises on cardiovascular variables in coronary artery bypass grafting patients

Anuja Khadilkar[1], Sneha Katke[2]
[1] B.P. Th, (Intern), MMC, College of Physiotherapy, Wanless Hospital, Miraj, Sangli, Maharashtra, India
[2] B.P.T., M.P.T., (Associate professor) MMC, College of Physiotherapy, Wanless Hospital, Miraj, Sangli, Maharashtra, India

Abstract
Introduction: Resistance exercises are strongly recommended for implantation in primary and secondary cardiovascular disease prevention programs. Also, resistance exercise applied with conventional cardiac rehabilitation protocols in CABG patients is recommended to increase in the functional capacity. The purpose of this study was to compare effect of concentric resistive and eccentric resistive exercises on cardiovascular variables in CABG patients.
Methods: A sample of n=20 CABG subjects between age group 55-65 years was selected for study. Patients on the day of discharge and one day before discharge were selected. Patients with unstable cardiovascular variables, musculoskeletal condition of upper limb and patients with neurological, respiratory disorders were excluded. Each subject performed concentric resistive exercises of biceps at 60% of 1 RM intensity till voluntary fatigue on day 1. On day 2, subject performed eccentric resistive exercises of opposite biceps at 60%+30% of 1 RM of concentric intensity with same number of repetitions as of concentric. Pre and post HR, BP and SpO_2 were measured.
Results: Statistical analysis was done using one-way anova test. The results shows that mean post HR after concentric exercise (87.6) was significantly higher than mean post HR after eccentric exercise (79.5) ($p<0.001$). Mean post SBP after concentric exercise (140.7) was significantly higher than mean post SBP after eccentric exercise (128.65) ($p<0.001$). Mean post DBP after concentric exercise (86.7) was higher than mean post DBP after eccentric exercise (82.3). Mean post SpO_2 after concentric exercise (88.4) was significantly lower than mean post SpO_2 after eccentric exercise (91.85) ($p=0.003$).
Conclusion: The eccentric resistive exercise imposes less stress on cardiovascular system as compared to the concentric resistive exercise in CABG patients. Hence, it is concluded that eccentric resistive exercises are recommended more than concentric resistive exercises in CABG patients.

Keywords: concentric resistive, eccentric resistive, heart rate, blood pressure, oxygen saturation

1. Introduction

Resistance exercise is defined as active exercise in which dynamic or static muscle contraction is resisted by an outside force applied manually or mechanically [6]. Dynamic resistance exercises can be performed as concentric resistive exercise and eccentric resistive exercise [1]. Concentric resistive exercise refers to a form of dynamic muscle loading in which tension in muscle develops and physical shortening of the muscle occurs as resistance is overcome [6]. Eccentric resistive exercise involves dynamic loading of a muscle causing physical lengthening of a muscle [6]. The changes in dynamic force are greater with eccentric training and greater mechanical efficiency and energy dissipation can be achieved with eccentric contractions [1].

There are many physical and physiological adaptations that occur as a result of consistent resistance training [1]. During resistance exercise several cardiovascular changes occur including increased systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), mean arterial pressure(MAP), stroke volume, cardiac output and decrease in oxygen saturation(SpO_2) [1, 6, 7, 10]. Resistance exercise has a positive effect on human musculature, connective tissue, bone formation and metabolism [1]. Resistance training proves to decrease myocardial demands during daily activities [3]. Also, it is strongly recommended for implantation in primary and secondary cardiovascular disease prevention programs [1].

Coronary artery bypass grafting (CABG) is defined as open-heart surgery in which a section of a blood vessel is grafted from aorta to the coronary artery to bypass the blocked section of coronary artery and improve the blood supply to the heart [9]. CABG surgery remains the most common operation performed by cardiac surgeons [9]. The cardiac rehabilitation protocols have been developed to restore patients' daily activities, emphasizing physical and educational activities aiming lifestyle changes [2]. Cardiac rehabilitation significantly improves functional capacity and some hemodynamic responses post CABG [8]. Aerobic exercises with resistive exercises have been performed to increase functional capacity of patient [2]. The benefits of resistance exercise associated to aerobic exercise include overall decrease of recurrent cardiac events, increased survival, physical and psychological independence, and improved quality of life [2].

Resistance exercise, applied early, promote maintenance of functional capacity in CABG patients, with no impact on pulmonary function when compared to conventional physiotherapy [2]. In normal individuals, eccentric activity imposes less stress on cardiovascular variables as compared to concentric activity [5]. But, there is lack of study done on the comparison of concentric and eccentric resistive exercise on cardiovascular variables in CABG patients which will help to clarify which type of resistance exercise should be given in post CABG patients.

2. Material and Methods

Ethical approval was obtained from Institutional Ethical Committee. A comparative study in CABG patients was conducted in tertiary care hospitals in Miraj. Sample was achieved by purposive sampling method. A total of 20 CABG patients were selected for this study from the tertiary care hospitals in Miraj. All subjects were recruited from the predefined selection criteria after taking an informed consent. Both male and female who underwent CABG in the age group of 55-65 years were selected. Intervention was done on the day of discharge and one day before discharge. Patients with unstable cardiovascular parameters, patients with musculoskeletal condition of upper limb, patients with neurological and respiratory disorders and uncooperative patients were excluded from this study. Any discomfort or patients reporting 17 or above on RPE scale during intervention would have led to immediate termination of the session.

On day 1, 1 RM for biceps concentric contraction was calculated with the help of dumbbells. Rest was given for 15 min in supine lying position and baseline Heart Rate (HR), Blood Pressure (BP) and oxygen saturation (SpO_2) measurements were taken. Then, the warm up exercise to upper limb for 5 min was done. Patients were asked to perform maximum concentric resistive contractions of biceps till voluntary fatigue with the 60% of 1 RM with the thera band [17] of same resistance. Post exercise HR, BP and SpO_2 measurements were taken. Rest was given for 5 min.

On day 2, rest was given in supine lying position and baseline HR, BP and SpO_2 measurements were taken. Then, the warm up exercise to opposite upper limb for 5 min was done. Patients were asked to perform eccentric resistive exercises of opposite upper limb biceps at 60%+30% of concentric RM intensity [4] with the thera band of same resistance. Patients were asked to perform same number of repetitions as of concentric exercise. Post exercise HR, BP and SpO_2 measurements were taken. Rest was given for 5 min. To eliminate the effect of dominance, half patients did concentric exercise on right biceps and half patients did concentric exercise on left biceps and vice versa for the eccentric exercises.

3. Results

Data was analyzed using SPSS version 20.0. One-way anova test was done to compare cardiovascular variables in CABG patients doing concentric and eccentric resistive exercises. A p-value less than or equal to 0.05 was considered as statistically significant.

Table 1: Effect of concentric and eccentric resistive exercises on cardiovascular variables in coronary artery bypass grafting patients

Exercises	Descriptive Statistics	N	Minimum	Maximum	Mean	Std. Deviation	F statistic	p value
Concentric	Pre-Heart Rate	20	63	88	75.1	6.95	24.07	<0.001
	Post Heart Rate	20	78	105	87.60	6.85		
Eccentric	Pre-Heart Rate	20	69	80	74.20	3.89		
	Post Heart Rate	20	74	86	79.50	3.76		
Concentric	Pre-Systolic BP	20	110	140	122.00	8.94	34.81	<0.001
	Post Systolic BP	20	130	152	140.70	7.82		
Eccentric	Pre-Systolic BP	20	110	130	119.80	6.35		
	Post Systolic BP	20	120	135	128.65	4.61		
Concentric	Pre-Diastolic BP	20	64	90	78.40	5.34	10.39	<0.001
	Post Diastolic BP	20	70	96	86.70	5.89		
Eccentric	Pre-Diastolic BP	20	63	87	78.10	5.48		
	Post Diastolic BP	20	70	90	82.30	5.67		
Concentric	Pre SpO_2	20	87	99	93.80	3.21	17.45	<0.001
	Post SpO_2	20	82	92	88.40	2.98		
Eccentric	Pre SpO_2	20	90	98	94.70	2.70		
	Post SpO_2	20	86	96	91.85	3.05		

Heart rate

It was found that there was significant difference between heart rate of patients ($p<0.001$).

Tukey's Post Hoc test was performed to check between which pair of exercises there was a significant difference.

It revealed that:

- Mean pre heart rate before doing concentric exercises was 75.1 which was significantly lower than post heart rate 87.6 ($p<0.001$)
- Mean pre heart rate before doing eccentric exercises was 74.2 which was significantly lower than post heart rate after doing concentric exercises 87.6 ($p<0.001$)
- Mean pre heart rate before doing eccentric exercises was 74.2 which was significantly lower than post heart rate after doing eccentric exercises 78.7 ($p<0.001$)
- Mean post heart rate after doing concentric exercises was 87.6 which was significantly higher than post heart rate after doing eccentric exercises 79.5 ($p<0.001$)

Systolic BP

It was found that there was significant difference between systolic BP of patients ($p<0.001$)

Tukey's Post Hoc test was performed to check between which pair of exercises there was a significant difference.

It revealed that:

- Mean pre sys olic BP before doing concentric exercises was 122 which was significantly lower than post systolic BP 140.70 ($p<0.001$)
- Mean pre systolic BP before doing concentric exercises was 122 which was significantly lower than post systolic BP 128.65 after doing eccentric exercises ($p=0.02$)
- Mean pre systolic BP before doing eccentric exercises was 119.8 which was significantly lower than post systolic BP after doing concentric exercises 140.70 ($p<0.001$)
- Mean pre systolic BP before doing eccentric exercises

was 119.8 which was significantly lower than post systolic BP 128.65 after doing eccentric exercises (p=0.001)
- Mean post systolic BP after doing concentric exercises 140.70 was significantly higher than post systolic BP after doing eccentric exercises 128.65 which (p<0.001)

Diastolic BP

It was found that there was significant difference between diastolic BP of patients (p<0.001)

Tukey's Post Hoc test was performed to check between which pair of exercises there was a significant difference.

It revealed that:

- Mean pre diastolic BP before doing concentric exercises was 78.4 which was significantly lower than post diastolic BP 86.7 (p<0.001)
- Mean pre diastolic BP before doing eccentric exercises was 78.1 which was significantly lower than post diastolic BP after doing concentric exercises 86.7 (p<0.001)

SpO_2

It was found that there was significant difference between SpO_2 of patients (p<0.001)

Tukey's Post Hoc test was performed to check between which pair of exercises there was a significant difference.

It revealed that:

- Mean pre SpO_2 before doing concentric exercises was 93.8 which was significantly higher than post SpO_2 BP 88.4 (p<0.001)
- Mean pre SpO_2 before doing eccentric exercises was 94.7 which was significantly higher than post SpO_2 after doing concentric exercises 88.4 (p<0.001)
- Mean pre SpO_2 before doing eccentric exercises was 94.7 which was significantly higher than post SpO_2 91.85 after doing eccentric exercises (p=0.018)
- Mean post SpO_2 after doing concentric exercises 88.4 was significantly lower than post SpO_2after doing eccentric exercises 91.85 which (p=0.003)

Overall, it can be seen that

- Mean post heart rate after concentric exercise (87.6) was significantly higher than mean post heart rate after eccentric exercise (79.5) (p<0.001)
- Mean post Systolic BP after concentric exercise (140.7) was significantly higher than mean post Systolic BP after eccentric exercise (128.65) (p<0.001)
- Mean post diastolic BP after concentric exercise (86.7) was higher than mean post diastolic BP after eccentric exercise (82.3)
- Mean post SpO_2 after concentric exercise (88.4) was significantly lower than mean post SpO_2 after eccentric exercise (91.85) (p=0.003)

4. Discussion

This study represents the first attempt, in our knowledge, to report on the comparison of effects of concentric resistive and eccentric resistive exercises on cardiovascular variables in CABG patients. Nevertheless, numerous studies have been performed on the effects of resistance training in CABG patients which states that resistance exercise, applied early, may promote maintenance of functional capacity on CABG patients. But, which exercises may put less stress on cardiovascular system was unclear. However, previous studies on normal individuals indicated that eccentric activity imposes less stress on cardiovascular system than concentric activity.

In the present study, the SBP and DBP both were increased in concentric resistive as well as eccentric resistive exercises. But, blood pressure was increased more after concentric resistive exercises than eccentric resistive exercises. In a study performed by tom J. Overend in 2000 shows posttest value of BP after concentric exercises was more than after eccentric exercises which is similar to our study. The increase in peripheral resistance during concentric contraction is more than eccentric contraction may be the possible reason behind this difference [1, 11]. During eccentric exercise there is decrease in peripheral resistance as compared to the concentric exercise [1]. Decrease in peripheral resistance during eccentric resistive exercise may be the reason behind lesser increase in DBP [1]. The pressor response to exercise includes all of the reflex-induced cardiovascular changes that serve to increase arterial blood pressure during muscle contraction [12]. When muscle produces tension eccentrically, greater torque is developed than in concentric contractions [15]. Also, the eccentric activity requires less muscle activation, the intramuscular forces are reduced than in concentric activity [11]. This may affect the lesser increase in blood pressure in eccentric resistive exercise than in concentric resistive exercise.

When posttest value of HR in present study was compared it was found that the HR increases more after concentric resistive exercises than eccentric resistive exercises. Similar result was found in a study performed by Akirti Gupta in 2018. Exercise mode, intensity, and duration, and size of active muscle mass are all factors related to the magnitude of increase in HR and BP during resistance exercise [11, 13]. More motor units are recruited in concentric exercise as compared to eccentric as stated by Okamoto *et al* because eccentric movement requires less muscle activation. The greater increase in cardiovascular stress with greater active muscle mass may be attributable to the increased HR in concentric resistive exercise than eccentric resistive exercise

In the present study, the post exercise oxygen saturation decreases. During exercise, the oxygen saturation becomes lower despite the same partial oxygen pressure during exercise [14]. In other words, the oxygen demand increases. In present study, the oxygen saturation decreases more in concentric exercises than in eccentric exercises. As stated by Meyer *et al* [15] eccentric contractions not only produce greater torque but also do so at greater reduced oxygen requirements. Takanobu Okamoto found out that muscle activity in concentric contractions increases than in eccentric contractions and oxygen supply to active muscle mass increases in concentric contractions [16]. There have been studies which shows that even when concentric and eccentric exercise are done against same amount of resistance the RPE rating given by subjects were higher for concentric exercises as compared to eccentric exercises [11].

5. Conclusion

The purpose of this study was to compare the effect of concentric and eccentric resistive exercises on cardiovascular variables in CABG patients. Results of this study conclude that the eccentric resistive exercise imposes less stress on cardiovascular system as compared to the

concentric resistive exercise in CABG patients. Hence, it is concluded from this study that eccentric resistive exercises are recommended more than concentric resistive exercises in CABG patients.

6. References

1. Gupta A, Ganai J, Malhotra D. Effects of Exercise Intensity on Cardiovascular Variables During Concentric and Eccentric Resistive Knee Extensors Exercises in Adults under Isotonic Condition. Indian Journal of Physiotherapy & Occupational Therapy, 2018; 12(1).
2. Ximenes NN, Borges DL, Lima RO, Silva LN, Costa MD, Baldez TE, Nina VJ, *et al*. Effects of resistance exercise applied early after coronary artery bypass grafting: a randomized controlled trial. Brazilian journal of cardiovascular surgery. 2015; 30(6):620-5.
3. Pollock ML, Franklin BA, Balady GJ, Chaitman BL, Fleg JL, Fletcher B, *et al*. Resistance exercise in individuals with and without cardiovascular disease: benefits, rationale, safety, and prescription an advisory from the committee on exercise, rehabilitation, and prevention, council on clinical cardiology, American Heart Association. Circulation. 2000; 101(7):828-33.
4. Doss WS, Karpovich PV. A comparison of concentric, eccentric, and isometric strength of elbow flexors. Journal of Applied Physiology. 1965; 20(2):351-3.
5. Okamoto T, Masuhara M, Ikuta K. Cardiovascular responses induced during high- intensity eccentric and concentric isokinetic muscle contraction in healthy young adults. Clinical physiology and functional imaging. 2006; 26(1):39-44.
6. Therapeutic exercises; Carolyn Kisner, Lynnallen Colby 7thedition; chapter-6,7.
7. Essentials of cardiopulmonary physical therapy 2nd edition; Ellen A. hillegass, H. steven sadowsky; chapter-16.
8. Ghashghaei FE, Sadeghi M, Marandi SM, Ghashghaei SE. Exercise-based cardiac rehabilitation improves hemodynamic responses after coronary artery bypass graft surgery. ARYA atherosclerosis. 2012; 7(4):151.
9. Diodato M, Chedrawy EG. Coronary artery bypass graft surgery: the past, present, and future of myocardial revascularisation. Surgery research and practice, 2014.
10. Neto GR, Sousa MS, Costa e Silva GV, Gil AL, Salles BF, Novaes JS, *et al*. Acute resistance exercise with blood flow restriction effects on heart rate, double product, oxygen saturation and perceived exertion. Clinical physiology and functional imaging. 2016; 36(1):53-9.
11. Overend TJ, Versteegh TH, Thompson E, Birmingham TB, Vandervoort AA. Cardiovascular stress associated with concentric and eccentric isokinetic exercise in young and older adults. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences. 2000; 55(4):B177-82.
12. Mitchell JH, Kaufman MP, Iwamoto GA. The exercise pressor reflex: its cardiovascular effects, afferent mechanisms, and central pathways. Annual Review of Physiology. 1983; 45(1):229-42.
13. Buck JA, Amundsen LR, Nielsen DH. Systolic blood pressure responses during isometric contractions of large and small muscle groups. Medicine and science in sports and exercise. 1980; 12(3):145-7.
14. Eroğlu H, Okyaz B, Türkçapar Ü. The effect of acute aerobical exercise on arterial blood oxygen saturation of athletes. Journal of Education and Training Studies. 2018; 6(9a):74-9.
15. Meyer K, Steiner R, Lastayo P, Lippuner K, Allemann Y, Eberli F, *et al*. Eccentric exercise in coronary patients: central hemodynamic and metabolic responses. Medicine & Science in Sports & Exercise. 2003; 35(7):1076-82.
16. Okamoto T, Masuhara M, Ikuta K. Differences of muscle oxygenation during eccentric and concentric contraction. Isokinetics and exercise science. 2006;14(3):207-12.
17. Nyberg A, Hedlund M, Kolberg A, Alm L, Lindström B, Wadell K, *et al*. The accuracy of using elastic resistance bands to evaluate muscular strength. The European Journal of Physiotherapy. 2014; 16(2):104-12.