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Case Report

Effectiveness of Short Length Cardiac Rehabilitation on Functional Capacity and Mental Status for Patient with Myocardial Infarction

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Abstract

Background and Purpose: Myocardial infarction (MI) is a life-threatening illness resulting in heart tissue damage due to blockage of coronary arteries. The survivors are commonly suffering limitations in their activity and increased anxiety levels. The evidence of the effectiveness of training programs for MI survivors is well established, but the short length of the program needs to be highlighted. This report investigates the impact of short length on the functional capabilities of a MI survivor post undergoing exercise programs.

Case Description: The selected case is a middle-aged male who underwent a revascularization procedure after suffering from a MI. The cardiologist stratifies the selected case as a low-risk case for exercise participation.

Outcomes: Pre and post-outcome measures involve the patient taking a walk for six minutes as a test (6MWT) and the Beck Anxiety Inventory (BAI) scale.

Discussion: The study results indicated an increased walking distance of 6MWT and reduced BAI score. Reduced rating perceived exertion scale (RPE) reactions to specified weights, and the responses were comparable in every training session. The patient put much effort into the training as he was enlightened on resistive training and professed the same weight used at the start to be much lighter at the end. There was a strong effect on resistive training as perceived by the patient after the training compared to the low perception at the training. RPE can be accepted as an alternative for HR observing and recording training for cardiac cases for prescribing the appropriate intensity.

Conclusion: The four-week cardiac rehabilitation training seems safe and beneficial for this post-MI patient's functional ability and mental status**.** However, these results cannot be generalized to all patients post MI and more research is recommended.

Keywords: *Myocardial Infarction (MI); Six Minutes as a Test (6MWT); Beck Anxiety Inventory (BAI); Rating Perceived Exertion Scale (RPE); ST-Segment Elevation Myocardial Infarction (STEMI); Non-ST-Segment Elevation Myocardial Infarction (NSTEMI); Coronary Artery Disease (CAD); Percutaneous Coronary Intervention (PCI)*

Background and Purpose

Scholars have proven that myocardial infarction (MI) causes death more often. The rapid death of heart tissue is caused by a lack of blood supply caused by a blockage of coronary arteries, which results in ischemic changes and dead infarct heart tissue [1]. Two clinical presentations are often seen in MI patients: ST-segment elevation myocardial infarction (STEMI) and non-ST-segment elevation myocardial infarction (NSTEMI) which frequently occur in MI patients [1]. MI is considered the major cause of abnormal heart function leading to heart failure and arrhythmias [1]. An estimated data shows that 16.5 million above 20 years old suffer coronary artery disease (CAD) and

that men suffer more from CAD than women [1]. In 2016, 67.8% was the rate of percutaneous coronary intervention procedure (PCI) in STEMI patients in the United States population, which rose from 32.8% in 2002 [2]. It is well-known that the MI population's poor physical and mental status is closely associated with poor mortality and morbidity [3]. Furthermore, poor mental health and higher anxiety levels are significantly seen in post-MI patients, representing a major pathway for the poor quality of life and increasing readmission chances [4].

Importantly, the massive impact of MI on health systems can be seen clearly through remarkable mortalities and morbidities rates, which facilitates the need to establish a health prevention strategy to reduce the complications and prevent other MI episodes [5]. There is a significant effect of cardiac rehabilitation programs on post MI patients. It has been revealed that physical activity correlates significantly with a low mortality rate for cardiovascular disease patients [5]. Also, physical activity helps the patients to attain a better living lifestyle [5]. It has been revealed that cardiac rehabilitation program positively affects MI patients' behavior management and physical activity facilitation [5]. Moreover, a well-structured cardiac rehabilitation program is significantly cost-effective and safe for cardiovascular patients [6].

According to a clinical study, exercise training is useful for MI patients who have received cardiac revascularization by a coronary artery bypass graft (CABG) [7]. Ischemia threshold levels compared to symptom-limited cardiopulmonary exercise testing (CPET) on a bicycle before and after cardiac rehabilitation program helped improve exercise tolerance. They also proved that the exercises were safe for the post CABG cardiac patients. The research also showed that the main cause for progress is dependent on the number of training sessions, regardless of the training length. However, it remained unclear if the shortened program would result in any changes in functional capacity [7]. The review study by Dibben concluded that exercise training programs are essential and beneficial for cardiac patients [8]. The author supports the evidence that the mortality and readmissions rate reduces significantly, indicating the beneficial effect of cardiac rehabilitation programs [8]. As the cost load on health services for cardiac patients reduces, the quality of life of those types of the population will improve [8].

A cochrane review by Linda., *et al*. concluded that the absence of cardiac rehabilitation program's affects the death rate of heart failure patients due to the program being less than 12 months [9]. Eleven randomized trials supported the conclusions. Furthermore, this analysis found fewer research studies that support cardiac rehabilitation programs and pieces of evidence that prove that cardiac rehabilitation program can reduce readmission rates and enhance the patients' worth lifestyle, especially those who suffer from heart failure. It was noted that the researchers warned that the papers considered could be biased. The quality of evidence provided by included trials was less effective due to a lack of concealment and a poorly blinded outcome evaluation [9].

In 2018, a study by Choo., *et al*. investigated how better living conditions, health related quality of life, mental fitness, and lifestyles can be achieved through cardiac rehabilitation [10]. The outcome measure was the hospital anxiety and depression scale (HADS), comparing pre-and post-cardiac rehabilitation intervention. Patients who completed ten cardiac rehabilitation sessions, according to the authors, had improved physical and emotional wellbeing. However, in addition to obtaining data from self-reports during the trial, this study did not consider any control sample for results comparison, which could weaken the quality of evidence. On the other hand, the findings were consistent with the previous studies in the literature that support the evidence that patients benefitted greatly in mental health through cardiac rehabilitation, especially those suffering from coronary heart disease or MI [10].

Strong evidence of meta-analysis and systemic review done by Zheng., *et al*. in 2018 supports the benefits of cardiac rehabilitation in reducing anxiety levels in victims of an MI [11]. The study's researchers concluded a significant effect on reducing anxiety levels for those suffering from MI when the patient engages in cardiac rehabilitation, reflecting the importance of cardiac rehabilitation as a preventive strategy for cardiac patients [11]. Furthermore, research by Mansilla-Chacón., *et al*. in 2021 shows that cardiac rehabilitation programs improve patients' quality of life [12]. Some of the papers included in this high-quality meta-analysis had tiny sample sizes, even though two authors monitored the risk of biased evaluation. The limitation of this analysis was the length of intervention, which was a short time [12].

However, many researchers have focused on the influence and effects of prolonged cardiac rehabilitation programs on functional capacity and mental strength based on individuals suffering from a cardiovascular illness. There were numerous and widely published studies of long-term cardiac rehabilitation programs. On the other hand, few studies have looked at the effects of short-term cardiac programs on mental health and exercise tolerance in MI patients. Studies need to investigate the effects of various exercises on MI patients when the cardiac rehabilitation period is shortened. As a result, this report aims to see how a four-week outpatient cardiac rehabilitation program with mixed aerobic and resistance exercise training affects anxiety levels and functional ability in a patient after an MI.

Case Description

Two months ago, a 56 years old married male who works as a school teacher complained of retrosternal pain radiated to the upper chest, inter-scapular region, and left arm. The pain was severe and was accompanied by dyspnea during physical exertion. When emergency blood working up and ECG was done, the results showed high troponin and CPK cardiac enzyme levels. Additionally, the ECG test revealed the ST-segment elevation that suggests MI. As a cardiac revascularization procedure, the patient was recommended for percutaneous coronary intervention (PCI). Antiplatelet agents (prasugrel) and anticoagulants were given with oxygen therapy. On the second day of admission, the patient went to the Cath lab for PCI to re-vascularize the cardiac tissue and open up blocked affected vessels.

The heart function was assessed through echo sonar, the heart function was well stable, and the ejection fraction was 60%. The infarct tissue was not massive, and the re-vascularizing procedure was successful and efficient. Beta-blockers, ACE II inhibitors, and statins medications were prescribed post-discharge. The patient was referred to cardiac rehabilitation for assessment and risk stratification of exercise participation. According to cardiopulmonary exercises testing, the cardiologist classifies the case as low to level risk agreeing with the American college of sports medicine (ACSM) criteria in table 1 of the appendix for selecting participants to partake in exercises and the intensity of the training participant can withstand. The exercise test, risk stratification, and refereeing for the patient exercises training were five to six weeks after discharging the case from the hospital.

Stratification of Risk for Cardiac Events During Exercise Participation	
Low Risk	Characteristics of patients at lowest risk for exercise participation (all characteristics listed must be resent for the patient to remain at the lowest risk)
	Exercise testing findings: Absence of complex ventricular dysrhythmia during exercise testing and recovery Absence of angina or other significant symptoms (e.g. unusual shortness of breath, lightheadedness, or dizziness during exercise testing and recovery). Presence of normal hemodynamics during exercise testing and recovery (i.e. appropriate increases and decreases in heart rate and systolic blood pressure with increasing workloads and recovery). Functional capacity >_ 7 metabolic equivalents (METs) Non-exercise testing findings: Rest ejection fraction (EF) 250% Uncomplicated myocardial infarction (Ml) or revascularization procedure. Absence of complicated ventricular arrhythmias at rest. • Absence of congestive heart failure (CHF) • Absence of signs or symptoms of post-event or post-procedure ischemia. • Absence of clinical depression.
Moderate Risk	Characteristics of patients at moderate risk for exercise participation (anyone or combination of these findings laces a patient at moderate risk)

High Risk	Characteristics of patients at high risk for exercise participation (anyone or combination of these findings laces a patient at high risk)
	Exercise testing findings: Presence of complex ventricular arrhythmias during exercise testing or recovery. Presence of angina or other significant symptoms (e.g. unusual shortness of breath, lightheadedness, or dizziness at low levels of exertion (< 5 METS) or during recovery). High silent ischemia (ST-segment depression 22 mm from baseline) during exercise testing or recovery. Presence of abnormal hemodynamics with exercise testing (i.e. chronotropic incompetence or flat or decreasing systolic BP with increasing workloads) or recovery (i.e. severe post-exercise hypotension). **Non-exercise testing findings:** Rest ejection fraction (EF) < 40% • History of cardiac arrest or sudden death. • Complex dysrhythmias at rest. • Complicated Ml or revascularization procedure. • Presence of CHF. • Presence of signs or symptoms of post-event or post-procedure ischemia. • Presence of clinical depression.

Table 1: *Risk stratification for exercises participation by ACSM guidelines [25].*

The history of this patient was reported during the cardiac rehabilitation interview. The report involved the history of illness as the case was diagnosed with diabetes mellitus. Also, the patient was treated for fractures on the distal radius of the right arm a few years ago. The patient was also diagnosed since his birth with G6PD disease. In addition, the patient reported that he was diagnosed with high cholesterol levels and had been under dyslipidemia management period before the MI event several years ago. There was no recurrent history of upper respiratory infections or urinary tract infections. The patient denied any history of major abdominal surgical procedures. Both of the patient's parents of the have been diagnosed with diabetes, hypertension, and heart disease.

The patient was previously prescribed a proton inhibitor pump (Nexium), simvastatin, insulin injections, glucophage diabetes medication, paracetamol, and vitamins D supplements. The patient's previous diagnosis and treatment included post-MI an antiplatelet and aspirin. Also, an antianginal (Nitroglycerin) and ACE II Inhibitors were administered. There is a denied history of smoking nether substance or alcohol. In the initial cardiopulmonary assessment, the patient's blood pressure was 149/85 with heart rate 79 beats per minute, and the respiratory rate was 17 per minute. There was no lower limb edema, ascites, and sacral edema. Also, no significant integumentary findings, lesions, skin bruising, or normal skin color were found. Normal skin textures, and there were no signs of dehydration.

The patient's weight was 67 kilograms with height of 1.48 meters, and the BMI was 31.9, which is overweight. The range of motion for all upper and lower limbs joints within the normal function ranges. The patient has no significant abnormality in the musculoskeletal system. The body was symmetrical and had a normal alignment. There was no significant abnormality in the neuromuscular system. The

patient independently has normal motor control with normal sensations. Also, there was no defect in gross coordination, movement, and balance. The patient's communication ability and skills were good, and he was focused and attentive to his environment and the people around him. Also, the patient is willing to respond to instructions and verbal commands.

Clinical impression I

The patient's main complaints was the shortness of breath during an effort with fatigue. The patient reported dyspnea increases during mobilization, caused by less physical activity. Other main complaints were stress due to dyspnea and fear of MI underlying threat. Dyspnea possibly can be caused by left ventricular dilatation [13]. Another possible reason for the dyspnea is frequent premature atrial and ventricular complexes [14]. Moreover, it is commonly seen in MI patients who start feeling short of breath due to progressing the condition to heart failure, which happens several weeks post-MI events [13]. Also, other possible causes include lung infection, beta-blockers side effects, anemia, or secondary ischemia [13]. Interestingly, Parodi., *et al*. revealed that the development of dyspnea is significantly associated with ticagrelor anti-platelets medication side effects [13]. However, the dyspnea due to ticagrelor is not presented as orthopnea and is not combined with chest pain. Also, there is no wheezing breathing sound with this type of dyspnea. It usually comes all of a sudden and during rest [13].

Examination

The tests and measures were selected based on case presentation and complaints. Before the initial testing, the patient was exposed to the resistance training routines to familiarize himself with the procedures. The key focus was on the patient's posture when lifting weights, breathing control, and proper exercise techniques. The instructor determined the weight to use during the exercise throughout the session. Examined tests included blood pressure, HR, and RPE levels when the patient practiced and rested. The angina pain scale was two during normal walking. Also, the ankle radial index was 0.85, which is common with those of cardiovascular diseases and may indicate lower limb moderate arterial blockage. The patient's blood pressure was 149/85, and heart rate was 79 per minute.

The heart auscultation shows normal S1 and S1 heart sounds. There was no S3 ventricular gallop or S4 atrial gallop. Also, no remarkable systolic or diastolic murmurs sound was heard during auscultation. In lung auscultation over sternum sides and between the scapula, there was a normal-bronchial loud sound with a pause between inspiration and expiration. There were no significant crackles, and stridor and chest were clear. Capillary refill time was abnormal and more than 3 seconds. According to Amorim., *et al*. a dyspnea Borg score is reliable for measuring short breathing levels [15]. In this case, the dyspnea Borg scale was 0/10 during rest, whereas it raised to 1-2/10 during normal walking.

Palpation of peripheral arterial pulses was regular and weak with slight difficulty palpation. The pulse oximetry was normal at 95%. The respiratory rate was assessed at 17 per minute with the normal depth of breathing. There is mild shortness of breathing when the patient is lying flat, which equals 1 to 2/10 on the Borg dyspnea scale [15]. RPE was used to measure the level of exertion during aerobic activity which was 8-12/20 during normal walking [16]. 6-Minute walk test evaluated the patient's capabilities and the extent to perform duties and walk normally when the patient completed the test. The measured distance was 264 meters per 6 minutes without any stops. The shortness of breathing was 2-3/10 on the Borg dyspnea score, whereas the RPE scale was 10-12/20 during the walk test. There were no abnormal symptoms like lightheadedness, chest pain, or palpitations during the test. HR was 94 bpm during the walk test, while the respiratory rate was 21.

Clinical impression II

Based on examination and clinical relevant finding, the low ischemic threshold post-MI might explain the fatigue symptom as cellular anaerobic respiration occurs. The cardiac function cannot meet the oxygen demands compensated physiologically by anaerobic

respiration. This leads to generating a musculoskeletal fatigue system. Crane., *et al*. indicated that fatigue is feasible, explaining mobility limitation in MI patients [17]. The level of anxiety is driven up by the feeling of choking and shortness of breath. Also, the patient's perception of his life and how serious the disease contributes significantly to the level of stress [17].

Intervention

Many post-MI patients suffer from limitations in their physical activity, which negatively enhances their stress levels [16]. Cardiac rehabilitation programs were a successful strategy to improve functional tolerance and reduce anxiety [16]. Both resistive and aerobic training has been proven to positively affect cardiac patients' functional capacity, mental health, and quality of life [16]. Also, the selected aerobic and resistive training with calculated intensities has been considered safe and feasible in the previous literature [16]. The patient will receive a combined aerobic and resistive training for four weeks in length. The frequency of visits will be twice weekly with 45 minutes duration for each session. Aerobic part for 30 minutes duration and resistive part for 15 minutes. The intensity of aerobic part is based on the stratification risk level. The risk stratification level is low according to cardiologist stratification. The training will be calculated through Karavon formula [18]. Aerobic training intensity will use a heart reserve rate (HRR) percentage to determine a heart rate training zone. The recommended percentage is 60% to 75% of HRR [18].

The resistance exercises included leg and bicep curl, leaning and extending leg, lat pulls down, triceps extension, shoulder press, leg, and chest. Further, the session involved free weight, cable station machines, and several resistive machines. Each exercise was repeated eight times at an RPE rating of 11-14/20. The trainer instructor guided the patient on proper body posture, stretching the body after the exercise, cooling down for 4 minutes, and the significance of doing a warm-up for 8 minutes before lifting weights. The patient should be able to continuously increase the weights lifted over the sessions concerning recommended intensity.

The calculated training intensity should correlate with dyspnea Borg scale training zones between 4 - 6 out of 10 and 11 - 14 out of 20 based on the RPE [16]. The strength in resistive training was calculated based on a repetition maximum (RM) percentage [19]. The recommended intensity for resistive training is 50% off RM for eight repetitions and three sets. The resistive training intensity should be consistent with Borg dyspnea score 4 to 6 /10 and 11 to 14 /20 on the RPE scale. The total accumulative sessions of training will be eight training sessions for four weeks. Extra sessions for assessment consist of one for baseline measures on the day of assessment before intervention and one session for the reassessment of the selected outcomes week after the 4^{th} week of the intervention.

Outcomes

The patient completed 8 sessions of cardiac rehabilitation exercise training during one month. The frequency of visits was twice in a weekly basis. The main outcomes were reported as basslines measures on the first day of assessment before intervention, 6MWT was 264 meters, and the Beck inventory anxiety scale shown in table 2 in appendix was 23 as baseline measures. The selected outcome measures are 6-minute walk test distance and beck inventory anxiety scale [16,20].

The Beck inventory scale recorded a higher value of 23 which then reduced after the short-term aerobic and resistive exercise to 16. The 6MWT distance at the baseline recorded 264 meters which increased to 381 meters post-training intervention. The training intensity focusing on various exercises like leg, shoulder, and bicep curl was analyzed in different sessions. The figures obtained implied a substantial reduction in RPE, SBP, and HR in all exercises performed. However, fewer changes were observed when the leg press exercise was done. There was a higher effect on RPE observed in all the exercises.

	Not at all	Mildly but did not bother me much	Moderately - it was not pleasant at times	Severely - It bothered me aloty
Numbness or tingling	0	1	2	3
Feeling hot	0	1	2	3
Wobbliness in legs	0	1	2	3
Un able to relax	0	1	2	3
Fear of worsts happening	0	1	2	3
Dizzy or lightheaded	0	1	2	3
Heart pounding/racing	0	1	2	3
Un steady	0	1	2	3
Terrified or afraid	0	1	2	3
Nervous	0	1	2	3
Feeling of choking	0	1	2	3
Hands trembling	0	1	2	3
Shaky/unsteady	0	1	2	3
Fear of losing control	0	1	2	3
Difficulty in breathing	0	1	2	3
Fear of dying scared	0	1	2	3
Indigestion	0	1	2	3
Faint/lightheaded	0	1	2	3
Face flushed	0	1	2	3
Hot/cold sweats	0	1	2	3
Column sum				

Table 2: *Beck anxiety scale template.*

Discussion

Maximum aerobic effort often evaluates degree influence on the resistive patterns on different parameters. According to Pierson., *et al*. circulatory responses to aerobic activities and improvement of fitness capacity can be tested using resistive and aerobic training [21]. Different aspects were tested where the exercise mode was varied, as shown in table 3 in the appendix. During lifting exercise, RPE, BP, HR, SBP, and DBP were obtained. The final test was 6MWT after the exercises, which significantly improved. Moreover, the level of anxiety has declined after four weeks of cardiac rehabilitation training. In day-to-day life, the patient encounters physical activities like any other person. The patient experienced chest pain and fatigue even by doing simple tasks. The report showed that the MI patient benefitted from the resistive and aerobic exercises sessions. As a result, the resistive training enabled the patient to gain more strength and boost his lifting capabilities [19]. The patient decreased the cardiac demand when the circulatory responded positively to training. The results are significant for MI victims and those at higher risk of further complications when participating in activities involving moderate to high-intensity exercise [22]. The results confirmed the previous research by Choo., *et al*. where patients who completed ten cardiac rehabilitation sessions, according to the author, had improved physical and emotional wellbeing [10].

Blood pressure and heart rate readings were recorded several times throughout the training course. Pre and post training were monitored, involving leg press (LP), shoulder press (SP), and bicep curl (BC). The result shows declined heart rate and SBP responses in

	Bicep Curl (BC)		Shoulder Press (SP)		Leg Press (LP)	
	Pre	Post	Pre	Post	Pre	Post
RPE	13.92	11.02	13.53	11.22	13.66	11.11
HR	85	81	89	84	84	83
SBP	145	137	143	138	141	134
DBP	86	84	87	83	84.7	83.2

Table 3: *Intensity of training (RPE= Rate of Perceived Exertion, DBP=Diastolic Blood Pressure, SBP= Systolic Blood Pressure, and HR= Heart Rate).*

all aerobics and resistive exercises. A remarkable decline in diastolic blood pressure (DBP) was noted in SP and BC. Also, SBP had higher reading during BC. A moderate impact was seen on DBP, SBP, and HR, indicating that resistive training is effective for hemodynamic changes. LP results shows little responses, even though the changes were not significant. The patient could use weights based on his perceived effort capability. The patient uses RPE, or evaluation of average pace, to determine the exact beginning loads for a specific set and reptations throughout weight lifting programs. Consequently, the RPE scale is an effective tool for assessing incremental effort and outcomes. The interpretation of the RPE reading might be a challenge to a patient that unfamiliar with the scale.

Reduced RPE reactions to specified weights were seen in this report, and the effects were consistent across training sessions. The patient put a lot of effort into the exercise because he had been educated on resistance training and said that the same weight he used at the beginning was significantly lighter at the finish. Compared to the low impression during the training, the patient felt a considerable effect on resistance training after the training. Aamot., *et al*. proved that RPE can be used in place of HR monitoring and recording in cardiac rehabilitation for appropriate prescription exercise [23]. The patient may elect to continue with aerobic and resistance workouts without being monitored, relying instead on the intensity of the exercise rather than the initial signs of the sickness. According to Heran., *et al*. cardiac rehabilitation can only yield noticeable changes to the patient if it is longer than twelve months, while short-length rehabilitation has no results on MI patients [24]. The results of that study contradict this report finding since the cardiac rehabilitation was done for four weeks, and positive results were obtained.

Conclusion

After short cardiac rehabilitation, this case report aimed to investigate a patient's functional capacity and anxiety status after an MI. The patient used for this study has significant improvement where the 6MWT increased in the distance from 264 meters to 381 meters, which was a noticeable change in 4 weeks. Similarly, the Beck inventory scale dropped from 23 to 16. The values of 23 indicated moderate anxiety in the patient, which lowered to 16, signifying low anxiety. The results of low anxiety were achieved through aerobic and resistance exercise. There is a significant positive effect where the anxiety status was lowered for those suffering from myocardial infarction, reflecting the importance of cardiac rehabilitation as a preventive strategy for cardiac patients. The report results show the possibility of treating MI using short-length cardiac rehabilitation on functional capacity and mental status. More studies are recommended since these findings cannot be generalized to all patients after MI.

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