Effectiveness of cardiac rehabilitation in patients with myocardial infarction and percutaneous coronary intervention at a tertiary care hospital: A pilot intervention study

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ABSTRACT

Background: Secondary prevention strategies, including structured cardiac rehabilitation (CR), following myocardial infarction (MI) and coronary interventions may reduce the burden of mortality and recurrent morbidity.

Objective: The objective of the study is to examine the effect of an adapted model of CR in patients who had experienced MI and had undergone percutaneous coronary intervention (PCI) in an Indian tertiary care hospital setting.

Materials and Methods: A quasi-experimental design using control group and pre-test was used with patients post-MI and PCI. Fifty patients were allocated to CR intervention group for 12 weeks of intervention care compared with 51 patients in standard routine care control group.

Results: After the 12-week program, participants in intervention group revealed a significant increase in coronary artery disease-related knowledge ($P < 0.001$), 6-minute walk test distance ($P < 0.001$), and high-density lipoprotein ($P < 0.05$). The level of physical activity was significantly higher in the intervention group in terms of mean duration of moderate or vigorous physical activity ($P < 0.05$) as well as mean of 10-minutes' continuous physical activity time at or above a moderate level ($P < 0.01$). Furthermore, depression levels ($P < 0.05$) and levels of glycated hemoglobin A1c significantly decreased ($P < 0.05$) in the intervention group. There were no changes observed in these parameters in the control group.

Conclusion: CR is feasible and effective as it potentially improved health in patients who have experienced MI and had undergone PCI at a tertiary care hospital. Barriers may be recognized which might hinder participation in CR in Indian settings.

Keywords: Cardiac rehabilitation, myocardial infarction, percutaneous coronary intervention, secondary prevention

Introduction

It has been estimated that non-communicable diseases (NCDs) are the cause of 61.8% of total deaths in India.[¹] The situation assumes alarming proportions due to the increasing prevalence of cardiovascular diseases (CVDs) in productive age groups which has increased to 24.8% among people between the ages of 25 and 69.[²] The contribution of NCDs in terms of disability-adjusted life years which estimate years of healthy life lost to premature death and suffering has increased from 30% of the total disease burden in 1990 to 55% in 2016.[¹]

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Coronary artery disease (CAD), a specific manifestation of CVD, is ubiquitous across the country with some regional variation (e.g., 2%–7% for rural areas and 7%–13% for urban areas).[^3] The age-standardized death rate has increased for ischemic heart disease (IHD) (12.0% [4.5%–21.3%]).[^1] IHD has been ranked as number one cause of years of life lost due to premature death with a percentage change of 41.5% between 2005 and 2016 in the country.[^4]

Acute myocardial infarction (MI) is often the first sudden event signaling CAD. It carries a heavy burden of mortality and recurrent morbidity, thus posing a major challenge to patients, their families and the health-care system. Evidence from different parts of the world indicates that structured approaches to secondary prevention such as cardiac rehabilitation (CR) have health-favoring impacts on quality of life (QOL), morbidity, and mortality. While percutaneous coronary intervention (PCI) along with medication aids acute management of MI with PCI, increasing evidence indicates that when these acute interventions are supplemented with CR, even better patient outcomes can be achieved regarding risk factor modification, rejoining work, and QOL.[^5][^4] This study aimed to explore the effects of an adapted model of CR in patients with MI, who had undergone PCI in tertiary care hospital settings.

**Materials and Methods**

This pilot study was undertaken in 101 patients with MI who had undergone PCI with 50 patients allocated to a CR intervention group and 51 patients allocated to standard routine care control group. The CR intervention was a 12-week program of risk factor modification with focus on increasing physical activity, education on CAD, and heart-healthy living. People aged ≥ 18 years diagnosed with MI and undergone PCI were enrolled in the study. People with medical conditions which could put them at risk during physical activity testing or training (e.g., unstable angina, heart failure, or arrhythmia) or conditions limiting the participant’s ability to exercise (e.g., severe orthopedic or neurologic impairments) were excluded from the study. Participants in the CR intervention care group underwent an adapted Phase II CR program (Adapted from Cardiac Rehab @ Home Service and Cardiovascular Prevention and Rehabilitation Program, Toronto Rehabilitation Institute, University Health Network, Toronto, Canada, and Chandigarh Healthy Heart Action Project, CHHAP, Chandigarh, India). The main focus was on increasing physical activity, education on CAD, medication adherence, and heart-healthy living. This program started at least 2–4 weeks after the participant was discharged from the hospital. Enrollment was done after the consulting Cardiologist assessed the participant and ruled out contraindications. Participants in the standard routine care group received usual care without any supervised physical activity training or goals. To ensure safety, at least 30 minutes were spent with each participant in the intervention group for orientation toward the program. Safety measures and clear instructions regarding the warm-up and cool-down practices associated with physical activity were also discussed. The Borg Scale was used for daily regulation of intensity of physical activity.[^7] Participant case history was taken. Assessment of functional capacity was done using 6-minute walk test (6-MWT) before and after CR program.[[^8] CAD education questionnaire short version (CADE-Q-SV) was used for assessing participants’ knowledge related to CAD.[[^9] Personal Health Questionnaire Depression Scale-8 (PHQ-8) was used for recording depression scores.[[^10] Physical activity was measured using a validated pedometer (PiezoRx[^11] manufactured by StepsCount Inc., Canada). Anthropometric measures height, weight, and waist circumference were recorded using weighing scales and constant tension tape. A complete lipid profile including total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), fasting glucose, and hemoglobin A1c (HbA1c) was also measured. The study protocol was reviewed and approved by the Institute Ethics Committee. Independent t-test was used to analyze the baseline data for the standard routine care group and CR intervention groups and physical activity data after 12 weeks. Paired t-test was used for analyzing changes in both groups after 12 weeks.

**Results**

Of 51 participants enrolled in the standard routine care group, 43 participants (84%), and of 50 participants in the intervention group, 40 participants (80%) stayed in the study until the end of 12 weeks of follow-up. As reported by the participants, financial, geographical, distance to hospital, family, and occupation-related barriers were the reasons leading to loss to follow-up. One participant died during the study duration. The mean age of participants in the standard routine care group was 56.8 ± 11.1 years and 54.2 ± 10.7 years in the intervention group. Majority participants were males in standard routine care group (86.1%) and intervention group (95%) reflecting less female representation. In the baseline assessment, standard routine care and intervention groups were not significantly different except for 6-MWT distance [Table 1].
Table 1: Comparison of baseline characteristics of patients in the standard routine care group and intervention group

| Parameters                          | Standard routine care group (N₁) | Intervention group (N₂) | P   |
|-------------------------------------|----------------------------------|------------------------|-----|
| Age (in years)                      | Mean (SD)                        | Mean (SD)              |     |
| Females/Males                       | 56.8 (11.1)                      | 54.2 (10.7)            | -   |
| CADE-Q SV Score (N₁ = 43, N₂ = 40) | 9.5 (3.4)                        | 9.1 (3.3)              | 0.56|
| 6-MWT (total metres walked in 6 minutes) | 312.8 (65.3)                  | 346.2 (49.96)        | 0.01*|
| PHQ-8 Score (N₁ = 43, N₂ = 40)     | 6.5 (5.3)                        | 6.0 (5.1)              | 0.64|
| Weight (kg) (N₁ = 43, N₂ = 40)     | 67.0 (13.0)                      | 68.3 (11.6)            | 0.64|
| Waist Circumference (inches) (N₁ = 43, N₂ = 38) | 98.7 (11.1)                  | 98.4 (14.8)            | 0.92|
| Body mass index (kg/m²) (N₁ = 43, N₂ = 38) | 25.6 (4.9)                     | 24.5 (3.5)             | 0.25|
| Fasting Blood Glucose (mg/dL) (N₁ = 36, N₂ = 30) | 103.6 (28.2)                 | 98.6 (8.9)             | 0.43|
| HbA1c (%) (N₁ = 29, N₂ = 32)       | 6.5 (1.0)                        | 6.6 (1.4)              | 0.90|
| Total cholesterol (mg/dL) (N₁ = 40, N₂ = 36) | 128.9 (29.3)                 | 132.2 (34.9)           | 0.46|
| LDL cholesterol (mg/dL) (N₁ = 36, N₂ = 34) | 66.8 (19.7)                    | 68.1 (33.2)            | 0.89|
| HDL cholesterol (mg/dL) (N₁ = 36, N₂ = 32) | 51.7 (59.4)                   | 37.0 (9.9)             | 0.32|
| Triglycerides (mg/dL) (N₁ = 35, N₂ = 33) | 134.0 (52.9)                  | 146.2 (79.1)           | 0.94|

Figure in parenthesis: N₁ = Number of participants in standard routine care group, N₂ = Number of participants in intervention group; SD = Standard deviation, * = percentage of female and male participants, * = significant P

Knowledge regarding coronary artery disease
It was found that there was a significant difference between mean CADE-Q SV scores before (9.1 ± 3.3) and after (14.1 ± 4.2) intervention in the intervention group (P < 0.01) with no difference in standard routine care group [Table 2].

Depression scores
The mean PHQ-8 score in the intervention group improved significantly from 6.0 ± 5.1 at baseline to 4.5 ± 4.4 after intervention (P = 0.03). However, there was no significant change observed in the standard routine care group [Table 2].

Functional capacity
In the intervention group, functional capacity in terms of total distance in meters walked over 6 minutes was 340.6 ± 52.1 before intervention and 411.7 ± 55.6 after intervention which was found to be statistically significant (P < 0.001). Furthermore, a significant difference was observed between distance covered in 6 minutes in the standard care group before and after intervention (P < 0.01) [Table 2].

Physical activity
A significant difference was observed between total mean duration (in minutes) of daily moderate-to-vigorous-intensity physical activity (MVPA). This value was total of the average 1-week MVPA undertaken by standard routine care group (457.5 ± 401.6) and intervention group (705.5 ± 553.7) after 12 weeks (P < 0.05). Furthermore, the mean of 10 minutes' continuous physical activity time at or above a moderate level was also significantly different for both groups (P < 0.01). The mean of 10 minutes' continuous physical activity time at or above a moderate level was 4.6 ± 7.8 min for standard routine care group and for the intervention group, it was 13.0 ± 12.7 min, i.e., higher in the intervention group [Table 2].

Anthropometric and biochemical factors
Table 2 shows that there was no significant difference in mean weight, mean waist circumference, mean body mass index (BMI), fasting blood glucose, HbA1c, and triglycerides before and after intervention period in both groups. After the intervention, mean HbA1c in the intervention group significantly improved to 6.0 ± 0.7 compared to 6.3 ± 0.9 before intervention (P < 0.05). There was a significant
| S. No | Variable                                      | Standard routine care group (N=43) | Intervention group (N=40) |
|-------|----------------------------------------------|------------------------------------|--------------------------|
|       | Mean (SD)                                   | Mean difference | Mean change (%) | P  | Mean (SD)                                   | Mean difference | Mean change (%) | P  |
|       | Before intervention period                  | After intervention period          |                         |     | Before intervention period                  | After intervention period          |                         |     |
| 1     | Knowledge regarding CAD                    | 9.5 (3.4)                      | 10.0 (3.53)             | 0.5 | 5.6 | 0.33 | 9.1 (3.3)                      | 14.1 (4.2)             | 5.0 | 54.7 | <.001* |
| N=43, N=40 |                                      |                          |                         |     |     |     | N=38, N=37                   |                          |     |     |       |
| 2     | Depression scores                           | 6.5 (5.3)                      | 5.9 (4.3)               | -0.6 | -9.6 | 0.30 | 6.0 (5.1)                      | 4.5 (4.4)               | -1.5 | -24.8 | 0.03* |
| N=43, N=40 |                                      |                          |                         |     |     |     | N=34, N=32                   |                          |     |     |       |
| 3     | Functional capacity (total metres walked in 6 minutes) | 321.1 (61.8) | 358.6 (107.1)           | 37.4 | 11.7 | 0.01* | 340.6 (52.1) | 411.7 (55.6) | 71.1 | 20.9 | <.001* |
| N=34, N=32 |                                      |                          |                         |     |     |     | N=39, N=37                   |                          |     |     |       |
| 4     | Total average MVPA (in minutes)             | -                          | -                      | -   | -   | -   | 457.5 (401.6) | 705.5 (553.7) | -   | 0.03* |
| N=39, N=37 |                                      |                          |                         |     |     |     | N=37, N=29                   |                          |     |     |       |
| 5     | Total average 10-minutes’ continuous physical activity time at or above a moderate level | -                          | -                      | -   | -   | -   | 4.6 (7.8)                      | 13.0 (12.7)             | -   | -   | <.001* |
| N=37, N=29 |                                      |                          |                         |     |     |     | N=29, N=16                   |                          |     |     |       |
| 6     | Weight                                      | 67.0 (13.0)                  | 66.7 (13.2)             | -0.2 | -0.4 | 0.55 | 68.3 (11.6)                  | 66.7 (13.0)             | -1.6 | -2.3 | 0.11  |
| N=43, N=40 |                                      |                          |                         |     |     |     | N=38, N=38                   |                          |     |     |       |
| 7     | Body mass index                             | 25.6 (4.9)                   | 25.5 (5.0)              | -0.1 | -0.4 | 0.49 | 24.5 (3.5)                   | 23.89 (4.1)             | -0.6 | -2.4 | 0.11  |
| N=43, N=38 |                                      |                          |                         |     |     |     | N=38, N=38                   |                          |     |     |       |
| 8     | Waist circumference                         | 99.0 (10.2)                  | 97.3 (10.9)             | -1.8 | -1.8 | 0.15 | 99.5 (17.6)                  | 99.3 (18.9)             | -0.2 | -0.2 | 0.96  |
| N=37, N=25 |                                      |                          |                         |     |     |     | N=37, N=25                   |                          |     |     |       |
| 9     | Fasting blood glucose                       | 103.6 (28.2)                 | 103.6 (34.1)            | 0.1  | 0.1  | 0.99 | 98.6 (8.9)                   | 99.0 (11.0)             | 0.4  | 0.4  | 0.90  |
| N=29, N=16 |                                      |                          |                         |     |     |     | N=16, N=12                   |                          |     |     |       |
| 10    | Glycated hemoglobin                         | 6.4 (0.7)                    | 6.3 (1.4)               | -0.1 | -0.8 | 0.85 | 6.3 (9)                      | 6.0 (7)                 | -0.3 | -4.3 | 0.04* |
| N=19, N=17 |                                      |                          |                         |     |     |     | N=17, N=12                   |                          |     |     |       |
| 11    | Total cholesterol                           | 128.9 (29.3)                 | 141.9 (29.1)            | 13.1 | 10.2 | 0.01* | 132.2 (34.9)                 | 145.5 (38.1)            | 13.2 | 10.0 | 0.04* |
| N=34, N=30 |                                      |                          |                         |     |     |     | N=30, N=24                   |                          |     |     |       |
| 12    | Low Density Lipoprotein                     | 66.8 (19.7)                  | 79.0 (18.8)             | 12.2 | 18.3 | 0.01* | 68.01 (33.2)                 | 87.3 (33.8)             | 19.2 | 26.2 | 0.01* |
| N=24, N=20 |                                      |                          |                         |     |     |     | N=20, N=18                   |                          |     |     |       |
| 13    | High Density Lipoprotein                    | 51.7 (59.4)                  | 47.0 (14.1)             | -4.8 | -9.3 | 0.71 | 37.0 (9.9)                   | 42.1 (9.2)              | 5.1  | 13.8 | 0.03* |
| N=24, N=18 |                                      |                          |                         |     |     |     | N=18, N=12                   |                          |     |     |       |
| 14    | Triglycerides                               | 133.9 (52.9)                 | 133.3 (54.4)            | -0.7 | -0.5 | 0.93 | 146.2 (79.1)                 | 164.6 (124.8)           | 18.4 | 12.6 | 0.36  |
| N=23, N=19 |                                      |                          |                         |     |     |     | N=19, N=14                   |                          |     |     |       |

Figure in parenthesis: N_1=Number of participants in standard routine care group, N_2=Number of participants in intervention group; SD=Standard deviation, *=significant P and **=10 minutes’ continuous physical activity time at or above a moderate level.

Note: S. No., i.e., Serial Numbers 1-3 and 6-14 have been analyzed using paired t-test and S. No. 4&5 have been analyzed using independent t-test.

increase in mean total cholesterol and LDL in the standard routine care group (P < 0.05) and the intervention group after the intervention period (P < 0.05). There was no significant difference in mean HDL levels before and after the intervention period in the standard routine care group, but there was a significant increase observed in the intervention group (P < 0.05).

**Discussion**

With a high level of participation and adherence over the 12-week program, this study demonstrated that a simple, structured CR education program might lead to improved physical activity patterns, functional capacity, knowledge on CAD, depressive scores, and risk profiles, all of which may address the secondary prevention of MI.

Post-MI, a patient undergoes major changes physically and mentally. In view of these changes, some patients experience depression, altered ability to perform physical activity and change in perception toward physical activity. Some patients have to compromise on working hours, feeling difficulty in returning to routine activities. Evidence suggests that CR can address these important issues and help improve patients’ QoL.[11] Educating patients and their families about CVDs can help in preventing recurrence of these diseases by modification of risk factors and improving health behaviors. Evidence suggests that educating the patient is important to increase knowledge and to provide them with a valid foundation for making decisions about their personal health.[12,13] CR also promotes physical activity through prescription and motivational counseling. This results in
Furthermore, LDL more than four-fold increased level of physical activity both in terms of overall capacity over a longer term. Our study showed an increased exercise capacity, trends toward improvement in lipid profile, and blood pressure can be observed. In an Indian rural hospital setting study, beneficial effects of exercise were seen on functional testing in patients post-MI. A non-randomized CR study in 15 ST-elevation MI patients in a rural hospital setting recorded beneficial effects of exercise seen as a faster return to baseline of heart rate following 6-MWT, delayed onset of exercise-induced ischemia, and lower rating of perceived exertion during 6-MWT.

Knowledge regarding CAD can help patients to have more control over their health and help in preventing disease recurrence. The latest evidence shows that adherence to CR helps in ensuring maintenance of participants’ knowledge necessary for making best management decisions with respect to disease and future health outcomes. A study compared knowledge of Canadian and Brazilian respondents participating in CR programs. The respondents from Canada scored significantly higher in total knowledge scores compared to Brazilian respondents. It was found from this study that a CR program with well-structured educational component can potentially add to the patient’s knowledge. This may prove to be conducive for changing behavior. Our study confirms that CR programs can significantly increase knowledge of patients in our settings using adapted materials, for example, in the form of pamphlets, highlighting risk factors for NCDs and communications developed around secondary prevention of MI.

In an Indian rural hospital setting study, beneficial effects of exercise were seen on functional testing in patients post-MI. Monitored physical activity in our study was more than four-fold. More than four-fold increases for the yoga group in the left ventricular function, BMI, blood glucose, and lipid profile. Non-randomized CR study in 15 ST-elevation MI patients in a rural hospital setting recorded beneficial effects of exercise seen as a faster return to baseline of heart rate following 6-MWT, delayed onset of exercise-induced ischemia, and lower rating of perceived exertion during 6-MWT.

Psychosocial interventions have been shown to reduce depression and improve levels of perception with respect to the social support. Depressive symptoms were assessed in a study for coronary patients who completed CR and those who did not. More than four-fold increase in mortality was observed in depressed patients compared to non-depressed patients. Mortality was lower in the depressed patients who completed rehabilitation. Depression scores in our study decreased significantly in intervention group participants, whereas no significant difference was observed in the standard routine care group. These findings agree with the past studies. This may be attributed to the education on stress management component of CR with the capacity to reduce depression levels by dealing with the stressors which are an important step further in improving overall health.

Anthropometric changes usually take a longer duration to show differences, and in our research, too, no significant differences could be seen during the relatively brief 12-week intervention period. Blood investigations showed a mixed picture of outcomes after CR. This may be because of inconsistent laboratory investigation reporting given financial barriers and distance to hospital leading to delayed submission or non-submission of reports by patients.

Change in biochemical factors is subject to the duration for change. In this study, HbA1c decreased and HDL increased for intervention group, indirectly suggesting CR patients might have been benefitted in terms of modification of atherosclerotic risk factors. Furthermore, LDL and total cholesterols were significantly different with respect to functional capacity at baseline, this result needs to be interpreted cautiously. Understanding of barriers in access to CR services is important for better service to participants and improved execution of the program. During our study, a peculiar geographoeconomical barrier was reported by participants, i.e., people coming from far off places reported difficulty in visiting the hospital due to economic reasons. Geographical barriers led to an inability to visit hospital settings or reach in time. Furthermore, it was...
difficult for agrarian participants to attend appointments because of harvesting and cultivation seasons, for example, apple cultivators of certain upper hilly areas of Himachal Pradesh, a state in India, found it difficult to frequent hospital between June and December. Globally, evidence suggests that structured CR programs may improve individual health and overall public health. Such programs are desperately needed in the developing countries like India where the dual burden of CDs and NCDs is so heavy. At the same time, barriers to participation in such programs need a better understanding to provide quality care.

Limitations of the study
Majority of participants were male, and thus, the effect of our CR model on women could not be adequately assessed. An attrition rate of about 20% was seen in both groups which is consistent with experiences of well-established CR programs in Canada and United States of America. Attrition due to various factors (e.g., time, interest, travel, family, and work commitments) and inability to obtain laboratory test reports due to financial barriers led to a depreciation in sample size, especially for biochemical test reports making it important to interpret the results cautiously. Systematic efforts are needed to assess the barriers to participation in CR which could not be done in this study. The duration of the study was short which might have led to only small changes in biochemical results. Confounding factors have also not been accounted for.

Conclusion
CR has been feasible and showed potential to improve health in patients of MI who have undergone PCI in tertiary care hospital setting by altering the risk factor profile for NCDs. Further evidence is needed which can be obtained from well-designed trials keeping in mind the possible barriers and limitations recognized in our study.

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Conflicts of interest
There are no conflicts of interest.

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