Brief Report

Assessment of Metabolic Risk Factors and Heart-Healthy Lifestyle in Atherosclerotic Coronary Artery Disease Patients Undergoing Percutaneous Coronary Intervention after a 6-Month Follow-Up

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Abstract

Background: Mortality due to acute coronary syndrome (ACS) has dramatically diminished because of performing life-saving interventions. This study aims to assess the metabolic risk factors and heart healthy lifestyle following the first episode of ACS under percutaneous coronary intervention (PCI) treatment after the 6-month follow-up. **Materials and Methods:** This is a longitudinal study conducted on 40 patients who underwent PCI because of the first episode of ACS. The patients' information including age, weight, abdominal circumference, smoking, functional capacity, patients' metabolic equivalent of task (METS), and laboratory tests including triglycerides (TGs), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), creatinine, fasting blood sugar (FBS), and hemoglobin A1C were recorded before discharge and reassessed after 6-month follow-up. **Results:** The patients were dominantly male (92.5%) with an average age of 56.8 ± 7.11 years. Physical activity and functional capacity (METS) significantly improved within 6 months ($P = 0.019$). BMI significantly improved; however, although the abdominal circumference decreased, it was not significant ($P = 0.28$). The number of smokers ($P = 0.12$) and the daily number of smoked cigarettes ($P = 0.37$) nonsignificantly decreased within 6 months. However, HDL-C ($P = 0.013$) and LDL-C ($P = 0.027$) changes were not desirable. TG, FBS, and blood pressure did not statistically significant change ($P > 0.05$). **Conclusion:** Although BMI, physical activity, and METS remarkably improved, waist circumference decreased nonsignificantly and lipid profile got worse paradoxically. Although this population is limited for generalization, this study shows that we require further schedules to improve ACS secondary prevention practice in our community.

Keywords: *Healthy lifestyle, metabolic, Metabolic Syndrome, risk factors, percutaneous coronary intervention*

Introduction

In general, based on the recent European Heart Health Charter recommendations, cardiovascular (CV) diseases are eminently preventable through primary prevention, early diagnosis, appropriate treatment approach, rehabilitation schedule, and secondary prevention.[1]

By emerging new life-saving interventions, for instance, percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG), mortality due to acute coronary syndrome (ACS) has remarkably declined but imposing the burden of a new chronic condition to the health-care system.[2,3] A vast majority of survivors would re-experience similar symptoms while ACS recurrence is generally attributed to the modifiable lifestyle factors, including behaviors, diet, smoking, physical activity, and occupational stress.[4] Exercise-based cardiac rehabilitation is considered a Class 1A recommendation, whereas physical activity is listed as a Class 1B intervention. Structured aerobic exercise, increased lifestyle physical activity, or both, are associated with an improved coronary risk factor profile, including decreased platelet aggregation, resting systolic and diastolic blood pressure, and intra-abdominal and total body fat, improved insulin sensitivity and blood lipid profiles, and enhanced cardiorespiratory fitness.[5]

Acute exposure to smoke triggers a cascade of adverse CV responses, including enhanced hypercoagulability, reduced oxygen delivery to the tissues, increased inflammation, and coronary

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vasoconstriction.[6,7] Compared with the salutary impact of moderate- and high-dose statin therapy in the IDEAL and TNT trials, smoking cessation was associated with more than double the reduction in absolute death rates, further supporting the need for smoking cessation interventions in the secondary prevention.

An estimated 1.1 billion adults worldwide are overweight or obese including 70% of US adults (130 million). Abdominal obesity has been linked with serious metabolic abnormalities, such as insulin resistance, hyperinsulinemia, hypertriglyceridemia, hypertension (HTN), and diabetes mellitus (DM), likely as a result of disrupting normal hormonal balance and increasing systemic inflammation. Waist circumference has a continuous, graded, and highly significant direct correlation with CV risk.[8] Body mass index has shown a modest graded association with MI; however, waist circumference is more strongly associated with metabolic risk factors, incident CV events, and death.

The lifetime incidence of HTN has been increasing in recent decades and is now 90% in the United States. Some previous studies show a 50% increase in long-term CV mortality risk for every 20-mm Hg increase in systolic BP above 115-mm Hg. Lowering elevated BP will lower risk of major CV events, regardless of age, race, sex, or other factors.[9,10] Aggressive HTN therapy targeted to achieve BP below 130/85 mm Hg is especially important in the presence of comorbid conditions, such as chronic kidney disease, heart failure, and DM.

In the INTERHEART study, the single most powerful CV risk factor was dyslipidemia. The effectiveness of statin therapy for improving the prognosis of patients with coronary heart disease (CHD) is supported by more long-term, high-quality, randomized controlled trial data than is the effectiveness of virtually any other CV treatment.[11] The lipid hypothesis has been repeatedly confirmed, demonstrating conclusively that lowering low-density lipoprotein cholesterol (LDL-C) improves the prognosis of patients with CHD. Statins are the drug class of choice for treating dyslipidemia and improving the prognosis of patients with CV disease. Statins lower LDL-C levels by 18% to 55% reduce the number of small dense LDL-C particles, raise high-density lipoprotein cholesterol (HDL-C) levels by 4% to 9%, and lower triglyceride (TG) levels by 7% to 30%. Large randomized trials have shown that intensive lowering of LDL-C levels to a range of 40–70 mg/dL improves the prognosis of patients with CV disease with minimal toxicity and no major safety concerns.

Patients with DM are at markedly increased risk of CHD, cerebrovascular disease, and peripheral arterial disease and thus are considered to have a CHD risk equivalent. CV disease continues to be the leading cause of mortality and morbidity among the DM population, accounting for 70% of all deaths.[12] Compared with non-DM patients, 1-month mortality rates after acute MI are 50% higher, and by 5 years, the cumulative mortality among patients with DM is twice the rate of that observed in non-DM post-MI patients. The UKPDS study has shown that regimens reducing average hemoglobin A1C (HbA1C) levels to <7% resulted in sustained reductions in retinopathy, nephropathy, and neuropathy.[13] More recent studies indicate that very aggressive regimens targeting HbA1C levels to <6.5% might increase risk of CV events, especially in persons with CHD who are experiencing the episodes of severe hypoglycemia.[14]

The current study aims to assess the metabolic risk factors and heart-healthy lifestyle following the first episode of ACS under PCI treatment after 6-month follow-up in our hospital. The main goal of the current study was to evaluate the effects of experiencing of ACS and the resulting procedure (PCI) on patient’s lifestyle over 6 months.

Materials and Methods

The current study is a longitudinal study conducted on 40 patients, based on a study by Gołuchowska and other,[15] who underwent PCI because of atherosclerotic arterial disease in the Chamran Hospital, from April 2016 to June 2017. The current study was confirmed by the Research Committee of Isfahan University of Medical Sciences and the Ethical committee has approved it (code of ethics: 397176). The inclusion criteria were as follows: Patients who underwent the first uncomplicated PCI with complete revascularization and written informed consent to participate in this study.

The presentation of the previous history of whether CABG or PCI, complicated PCI, and ST-elevated myocardial infarction were considered as the unmet criteria. Furthermore, patients who did not refer for the 6-month follow-up visits and those who died before 6 months following the PCI were excluded from the study.

All included patients were requested to fill the forms before the hospital discharge and then after 6 months following the PCI. The patients’ demographic information, including age, gender, income, educational level, medical history (i.e. DM, HTN, hyperlipidemia, cardiac ischemic diseases, thyroid diseases, and renal diseases …), and drug history was recorded in the checklist. Cigarette smoking was defined as the number of smoked cigarettes per day and duration. Furthermore, patients’ weight (in kilograms using a calibrated digital device), height (in centimeters using a single-height gauge), abdominal circumference (in centimeters using a bar meter by measuring the circumference of the abdomen at the midpoint between the anterior iliac spine and the last intercostal area), systolic and diastolic blood pressure from both hands (in millimeters of mercury (mmHg) using a single upper arm digital blood pressure monitor), patients’ metabolic equivalent of task (METS)[15] (through exercise tolerance test according to bruce protocol), physical activity (based on the Leisure-time Physical Activity Questionnaire categorizing into mild, moderate, and strenuous); also, the number of times per week and duration of each exercise was recorded [Table 1]. High reliability and relatively moderate validity of this questionnaire were found for the Persian population.[16]

Moreover, laboratory tests, including fasting blood sugar (FBS), blood urea nitrogen, creatinine, HbA1C, TGs, total cholesterol, HDL-C, low-density lipoprotein (LDL-C), and complete blood count, were recorded from all of the patients before discharge. All of the tests were taken by a targeted laboratory to eliminate the kit-related deviations. Like other patients, they received face to face training for heart-healthy lifestyle modification equally by a cardiology resident. All of the variables above were measured again after 6 months following the PCI as well. In order to minimize the inter-observer bias, the interviews were performed by a single resident of cardiology.

Obtained data were entered into the Statistical Package for the Social Sciences (SPSS) software (version X, IBM Corporation, Armonk, NY) version 21 and analyzed. Continuous and categorical variables were presented in mean ± standard deviation and number (percentages), respectively. For analytics, the *t*-test, McNemmar, Wilcoxon test, and Chi-square tests were used. $P < 0.05$ was considered as statistically significant level.

Results

In this study, 40 patients treated with PCI were evaluated. The patients were dominantly male (92.5%), married (97.5%) with the average age of 56.8 ± 7.11 years, and education level of the diploma or less (40%). Most of the study population had a monthly income of 1–2 million Tomans (52.5%) [Table 2]. The past medical history of the studied population was recorded on the basis of histories, medications, and associated evidence. Treated hyperlipidemia, ischemic heart disease (chronic coronary syndrome and positive previous noninvasive test), and DM have the highest rates [Table 3]. 32.5% of patients were smoker before the PCI (average duration of smoking: 15.07 ± 3.04 years) while it turned to 22.5% in the 6-month follow-up visit ($P = 0.12$). The number of smoked cigarettes per day did not statistically change within 6 months following the PCI (7.75 ± 6.75 vs. 6.87 ± 6.35; $P = 0.37$).

Twenty-five percent of the patients presented physical activity before the PCI that most of them had moderate physical activity and follow-up assessments showed that 52.5% of patients had physical activity within 6 months. The physical activity performance has changed significantly ($P = 0.019$), while the intensity of physical activity did not statistically alter ($P = 0.56$). Walking (45%) and cycling (31%) were the most prevalent [Table 4].

Table 1: Leisure time exercise questionnaire

Activity	Frequency
1. Considering a 7-day period (a week), how many times on the average do you do the following kinds of exercise for >15 min during your free time (write in each circle the appropriate number)	Times per week
A: Strenuous exercise (heart beats rapidly) (i.e. running, jogging, hockey, football soccer, squash, basketball, cross country, skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling)	
B: moderate exercise (not exhausting (i.e. fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)	
C: Mild exercise. (minimal effort) (i.e. yoga, archery, fishing from river bank, bowling, horseshoes, golf, snowmobiling, and easy walking)	
2. Considering a 7-day period (a week), during your leisure-time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?	
OFTEN SOMETIME NEVER/RARELY	
1. ❑ 2. ❑ 3. ❑	

Table 2: Demographic information of the study population

Variables	Frequency (%)
Gender	
Male	37 (92.5)
Female	3 (7.5)
Marital status	
Married	39 (97.5)
Single	1 (2.5)
Income	
<133$	29 (72.5)
>133$	11 (27.5)
Insurance	
Yes	40 (100.0)
No	0 (0.0)
Medical history	
Yes	33 (82.5)
No	7 (17.5)
Educational level	
Illiterate	10 (25.0)
Diploma or less	14 (40.0)
More than the diploma	15 (35.0)

*Based on the economic studies in Iran, the poverty line in metropolitans is 133$[30]

HDL-C ($P = 0.013$) and LDL-C ($P = 0.027$) changes were not desirable. BMI significantly improved ($P = 0.003$); however, although the abdominal circumference decreased, it was not significant ($P = 0.28$). Among all 40 patients, 38 ones (95%) were under statin treatments (Atorvastatin 40 mg [15.8%], 20 mg [50%], and 10 mg [10.5%]), rosuvastatin 10 mg (7.8%), rosuvastatin 5 mg (13.1%), and lovastatin 10 mg (2.6%). Hence, despite the prevalence of hyperlipidemia, lipid profile levels were in the normal

Table 3: The past medical history of the studied population

Past medical history	*n* (%)
Hyperlipidemia	15 (37.5)
Ischemic heart disease	13 (32.5)
Diabetes mellitus	11 (27.5)
Hypertension	10 (25)
Pulmonary disease	2 (5)
Thyroid disease	2 (5)
Stroke	1 (2.5)
Renal disease	1 (2.5)

Table 4: Comparison of smoking and physical activity status before the hospital discharge and within 6 months following the percutaneous coronary intervention

Variables	Before PCI, *n* (%)	Within 6 months after PCI, *n* (%)	*P*
Smoking			
Yes	13 (32.5)	9 (22.5)	0.12
No	27 (67.5)	31 (77.5)	
Physical activity			
Yes	10 (25)	21 (52.5)	0.019
No	30 (750)	19 (47.5)	
Physical activity intensity			
Mild	3 (33.3)	2 (10.5)	0.56
Moderate	4 (44.4)	17 (89.5)	
Strenuous	2 (22.2)	0 (0)	

PCI: Percutaneous coronary intervention

Table 5: Comparison of atherosclerotic risk factors before the hospital discharge and after 6 months follow-up assessments

Variable	Mean±SD		*P*
	Before discharge	Within 6 months after PCI	
BMI	28.60±3.54	28.11±3.48	0.003
Waist	98.59±9.25	98.13±8.93	0.28
SBP	117.15±13.58	119.65±14.87	0.27
DBP	73.75±10.01	74.23±10.61	0.45
METS	11.82±2.38	12.97±2.43	0.006
Hb	14.52±1.22	15.09±1.20	0.006
CHOL	136.54±29.73	143.08±39.24	0.14
TG	138.36±60.68	142.40±71.82	0.67
HDL	37.82±8.21	35.30±7.26	0.013
LDL	66.53±21.47	75.55±26.33	0.027
BUN	15.12±3.18	14.35±3.36	0.21
Cr	1.10±0.16	1.11±0.16	-
FBS	106.51±33.72	105.73±27.62	0.85
HbA1C	6.86±0.90	6.57±1.12	0.48

SD: Standard deviation, BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, METS: Metabolic equivalent of task, Hb: Hemoglobin, CHOL: Cholesterol, TG: Triglyceride, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, BUN: Blood urea nitrogen, Cr: Creatinine, FBS: Fasting blood sugar, HBA1C: Hemoglobin A1C, PCI: Percutaneous coronary intervention

ranges at the study initiation before discharge. After 6 months, 3 ones stopped taking the statin because of side effects (myalgia in one case due to the increased dose of the drug) or improved lipid test result (in two cases).

TG, FBS, and blood pressure did not statistically significant change ($P > 0.05$) [Table 5].

ACEI (captopril 25 mg and enalapril 5 mg) ARB (valsartan 80 mg and 160 mg, losartan 25 mg and 50 mg [Amlodipine 5 mg], Triamterene-H and Hydrochlorothiazide 25 mg and 50 mg) were prescribed to treat HTN. Forty percent of patients received combination of these drugs. Metformin 500 mg, glibenclamide 5 mg, gliclazide 80 mg, and insulin (lantus, regular, NPH, novomix, and novorapid) were prescribed to treat HTN. 22.5% of patients received the combination of these drugs.

Discussion

We showed that BMI, METS, HDL-C, LDL-C, and hemoglobin changed significantly after 6 months.

Huxley *et al.* pooled 26 papers assessing cigarette smoking statuses following ACS incidence in 2011. Although they presented a 2% increase rate in the smoking status of patients by each year during follow-up, they also reported no change in the rate of smoking patients who were not ex-smokers.[17] Consistent with our findings, other studies presented a decrease in both the number of smokers and the intensity of smoking following ACS.[18-20]

Here, we showed that the physical activity of patients dramatically increased within 6 months following the PCI performance. We believe that the main cause of this issue is due to the recommendations about the importance of routine physical activities for the prevention of re-experiencing similar life-threatening symptoms,[5,21] but patients' caution of intensive activity performance may be attributed to the limitations that they have experienced following heart attack, the recommendations for prohibiting intensive activities, and eventually due to the reluctance of the patients for exercising.[22,23]

We observed a remarkable increase in METS that can represent our successful performance of complete revascularization providing condition well-tolerating physical activity and also the increase in the functional capacity reflects an increased level of exercise.[5,21-23] Furthermore, a statistically significant decrease in BMI was detected. Although this change was appreciable, the abdominal circumference as an indicator of the metabolic syndrome decreased but had not significantly changed. Moreover, the primary and decreased BMI were both in overweight entities (28.60 ± 3.54 vs. 28.11 ± 3.48; $P = 0.003$). In addition to mentioned factors, FBS (106.51 ± 33.72 vs. 105.73 ± 27.62; $P = 0.85$) and HbA1C (6.86 ± 0.90 vs. 6.57 ± 1.12; $P = 0.48$) were in prediabetic entities and did not considerably improve within 6 months following the PCI. It has been established that baseline glycemic status is a predictor for the ACS recurrence.

A recent study was performed by Kim K-W *et al.* in 2017 on 851 patients over several years. They indicated that there is a significant negative correlation with the length of time since smoking cessation in ex-smokers and insulin resistance; DM and abdominal circumference are the most reliable predictors of insulin resistance. With a longer period of smoking cessation, insulin resistance tended to decreased.[24] We believe that this 10% increase in smoking cessation justifies these findings. As reported earlier, the worse condition was observed assessing lipid profile, while the serum levels of LDL-C (66.53 ± 21.47 vs. 75.55 ± 26.33; $P = 0.027$) and HDL-C (37.82 ± 8.21 vs. 35.30 ± 7. 26; $P = 0.013$) remarkably increased and decreased. However, the increase in LDL-C level and decrease in HDL-C level did not exceed the demanded levels.

Among all 40 patients, 38 ones (95%) were under statin treatments (atorvastatin 40 mg [15.8%], 20 mg [50%], 10 mg [10.5%]), rosuvastatin 10 mg (7.8%), rosuvastatin 5 mg (13.1%), and lovastatin 10 mg (2.6%). Hence, despite the prevalence of hyperlipidemia, lipid profile levels were in the normal ranges at the study initiation before discharge. After 6 months, 3 ones stopped taking the statin because of side effects (myalgia in 1 case due to the increased dose of the drug) or improved lipid test result (in two cases). Gregory G and others presented that daily use of post-ACS atorvastatin could successfully prevent its recurrence, but its efficacy was not related to the presence or absence of metabolic syndrome.[25] This highlights the importance of education for continuing medication despite of improvement.[26,27] Koba and others conducted exercise-based rehabilitation in 2016 and declared a remarkable increase in the HDL-C levels.[28] These results are not in line with what we reported, and this difference may be due to the differences in the duration of the follow-up or exercise intensity and change in statin use in our study.

Here, we also indicated that hemoglobin significantly increases 6 months after successful PCI (14.52 ± 1.22 vs. 15.09 ± 1.20; $P = 0.006$). Furthermore, in another study by Redfors B *et al.*, they found that 78.7% of patents had a drop in Hgb and Δ Hgb ≤ 1.0 g/dl was more common.[29]

Conclusion

Here, we showed that the BMI, physical activity, and METS remarkably improved, but the number of smokers, the daily number of smoked cigarettes, and waist circumference decreased none significantly and lipid profile got worse paradoxically addition to mentioned factors, FBS and HbA1C were in prediabetic entities and did not considerably improve within 6 months following the PCI. Although this population is limited for generalization, this study shows that we require further schedules to improve ACS secondary prevention practice in our community. We also lost some samples during the follow-up. Other limitation of our study was the follow-up duration. We suggest that more studies on larger populations and longer duration of follow-up should be performed.

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Conflicts of interest

There are no conflicts of interest.

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