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Effect of Smoking Cessation on Left Ventricular Ejection Fraction after Acute ST Elevation Myocardial Infarction

Parisa Janjani, Javad Azimivaghar, Nahid Salehi, Reza Haidari Moghadam, Mohammad Shakiba, Soraya Siabani, Hassan Azarpara, Mina Tahmasebi, Mohammad Rouzbahani

Original Article

Abstract

BACKGROUND: Acute Myocardial Infarction (AMI) is the leading cause of global mortality. Moreover, Left Ventricular Ejection Fraction (LVEF) is the most important predictor of post-AMI mortality. Thus, the present study aimed to investigate the relationship between smoking cessation and LVEF following one year from the STEMI.

CASE REPORT: The present study was a part of the Kermanshah STEMI Registry and included 825 smokers admitted to Imam Ali Hospital, Kermanshah, Iran, with AMI during a 2-year study period. Data collection was performed using the standardized case report form by the European Observational Registry Program (EORP). Moreover, multiple logistic regression was used to compare LVEF between the patients who had quit smoking post-AMI and those who were still smokers after one year. Also, one-to-one Propensity Score Matching (PSM) was used to reduce the assessment error and selection bias, increase the result accuracy, and minimize the effects of confounders on the LVEF-smoking relationship.

RESULTS: Following one year after AMI, 219 (26.55%) patients had quit smoking, while 606 (73.45%) still smoked. Using the PSM, a total of 168 ex-smokers were matched to 168 current smokers. Moreover, it was shown that LVEF was higher in current smokers compared to ex-smokers. However, the difference was not significant. Also, multiple logistic regression showed that the Odds Ratio (OR) of LVEF reduction was insignificantly higher in ex-smokers (OR=1.13; 95% CI: 0.98-1.29) compared to current smokers. Multivariate regression analysis found similar results even after the application of PSM (OR 1.02; 95% CI: 0.82-1.22).

CONCLUSIONS: Given the low rate of smoking cessation after MI, physicians are recommended to ask about the smoking status of MI patients at each office visit or re-admission and strongly recommend quitting smoking.

Keywords: Myocardial infarction, Registry, Iran, Left ventricular ejection fraction, Smoking cessation

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Cardiovascular Research Center, Health Institute, Kermanshah University of Medical Sciences, Kermanshah, Iran.

Address for correspondence: Mohammad Rouzbahani, Cardiovascular Research Center, Health Institute, Kermanshah University of Medical Sciences, Kermanshah, Iran. E-mail address: Dr_rouzbahani78@yahoo.com

Introduction

As the leading cause of global mortality and morbidity, Acute Myocardial Infarction (AMI) is a disease with a considerable economic burden (1). According to reports, the prevalence and mortality of AMI have been reducing in most countries (2, 3), which is due to recent advances in its prevention, treatment, and care (4). However, the increasing age of the population, population growth, and long-term post-AMI survival have led to the increasing burden of the disease (3). Moreover, it has been shown that MI survivors are at an increased risk of recurrent MI, other cardiovascular events, and death (5).

On the other hand, smoking is a main risk factor for Cardiovascular Diseases (CVDs). It has a direct relationship with the incidence of CVDs, while indirectly leading to adverse clinical events that increase the risk of CVDs, such as decreasing the Left Ventricular Ejection Fraction (LVEF) (6). The health benefits of smoking cessation are well illustrated. For instance, smoking cessation decreases the risk of mortality due to Coronary Artery Disease (CADs) by 30%-50% in the affected patients (7, 8). It has been shown that patients stop smoking during a hospital stay due to MI. However, most of them resume smoking within a short time after discharge despite the recommendations by their physicians (9). Therefore, the present study aimed to investigate the relationship between smoking cessation and LVEF at the one-year follow-up visit in patients with ST Elevation MI (STEMI).

Material and Methods

Study design and population

The present study was a cross-sectional study conducted at the Imam Ali Cardiovascular Center, Kermanshah University of Medical Sciences (KUMS), western Iran. This hospital is the main cardiovascular care facility in western Iran, providing more than two million people, who are mostly Kurds, with healthcare services each year.

Inclusion and exclusion criteria

The present study included all adult (aged 18 or more) patients presented to the Imam Ali Hospital from July 1, 2016, to July 1, 2018, (2 years) who were diagnosed with STEMI and were smokers at the time of presentation. Moreover, the patients gave written informed consent for participation. Also, those who were unwilling to participate, did not complete the study, or those with incomplete data were excluded.

The diagnosis of STEMI was made based on the European Society of Cardiology/ACCF/AHA/World Heart Federation Task Force for the Universal Definition of MI as follows: 1) chest pain for more than 20 minutes within the last 24 hours before admission and 2) electrocardiographic changes suggesting of new ST-segment elevations or left bundle branch block (10).

Data collection and quality control

The present study used the case report forms developed by the European Observational Research Program (EORP) for data collection, which was performed by a nurse and a research assistant previously instructed about the study protocol. Then, all completed questionnaires were checked for errors by a general physician before the final analysis, and the data were adjudicated by the standards of the EORP (11).

Following one year after the incidence of MI, all patients were invited for a follow-up visit and underwent electrocardiographic investigations. Moreover, the patients were asked about resuming smoking. In case of a positive answer, the frequency of smoking was asked as well. The patients who were still smokers at the time of the follow-up visit were recorded.

Statistical analysis

Data were analyzed using descriptive statistical indices, including mean, Standard Deviation (SD), median, frequency, and percentage, wherever applicable. We conducted the Propensity Score Matching (PSM) analysis to overcome the effect of possible selection

bias and to further control for potential confounding factors. This analysis tries to compare the outcomes between the patients with similar distributions of all covariates measured, thereby clarifying the effects of variables on the outcome. Moreover, matching was performed using a 1:1 matching protocol without replacement (greedy-matching algorithm/nearest neighbor matching). Thus, current smokers were considered as the exposed group and were matched with the ex-smokers as the unexposed group. Also, the association between smoking and LVEF was investigated using univariate and multiple logistic regressions. The significance level was set at 0.05. Finally, statistical analysis was performed using the STATA software version 14.1 (Stata Corp, College Station, TX, USA).

Ethical approval

The study protocol was approved by the Ethics Committee of the KUMS (Ethics No. KUMS. REC.1398.1215). Moreover, all patients were informed about the study goals and steps and gave written informed consent. Also, the confidentiality of the patients' data was assured. The data were only accessible to two researchers and the quality control physician.

Results

According to our results, 825 patients met the inclusion criteria (without considering those excluded due to missing covariate data), consisting of 219 and 606 patients in the unexposed and exposed groups, respectively. Using the PSM, a total of 168 unexposed patients were matched to 168 exposed patients. Moreover, 606 out of 825 patients (73.45%) had resumed smoking at the one-year follow-up visit, while 219 out of 825 patients (26.55%) had quit smoking. The demographic characteristics of the matched and unmatched participants are presented in Table 1.

According to the results of the multiple logistic regression, the Odds Ratio (OR) of reduced LVEF was higher in the unexposed group [OR=1.13; 95% Confidence Interval (CI): 0.98-1.29] compared to the exposed group. However, the difference was not significant. Moreover, the OR of reduced LVEF remained higher in the unexposed group compared to the exposed group even after the PSM application (OR=1.02; 95% CI: 0.82-1.22, Tables 3 and 4).

Table 1. Demographic characteristics of study participants based on smoking status

Variables		Smoking					
		Full population		p-value	Propensity score matched		p-value
		Ex-smoker	Current smoker		Ex-smoker	Current smoker	
		N= 219	N= 606		N= 168	N= 168	
Age (year)	35-45	81 (37.0%)	288 (47.5%)	0.104	62 (36.9%)	70 (41.7%)	0.096
	46-55	129 (58.9%)	285 (47.0%)		99 (58.9%)	86 (51.2%)	
	56≤	9 (4.1%)	33 (5.5%)		7 (4.2%)	12 (7.1%)	
Gender	Male	219 (100%)	573 (94.5%)	0.855	168 (100%)	135 (80.3%)	0.837
	Female	0 (0%)	33 (5.5%)		0 (0%)	33 (19.7%)	
Diabetes mellitus		30 (13.7%)	75 (12.4%)	0.959	23 (13.7%)	22 (13.1%)	0.969
Hypertension		75 (34.2%)	171 (28.2%)	0.007	57 (33.9%)	61 (36.3%)	0.007
Hyperlipidemia		51(23.3%)	99 (16.3%)	0.166	39 (23.2%)	38 (22.6%)	0.138
Prior PCI/CABG		3 (1.4%)	36 (5.9%)	0.054	2 (1.2%)	4 (2.4%)	0.053
Prior MI		21 (9.6%)	66 (10.9%)	0.058	16 (9.5%)	18 (10.7%)	0.052
Prior stroke		6 (2.7%)	18 (3.0%)	0.015	5 (3.0%)	6 (3.6%)	0.112
Aspirin use		192 (87.7%)	185 (84.5%)	0.524	147 (87.5%)	148 (88.1%)	0.526
Clopidogrel use		153 (69.9%)	420 (69.3%)	0.170	117 (69.6%)	119 (70.8%)	0.191
Warfarin use		6 (2.7%)	9 (1.5%)	0.561	5 (3.0%)	6 (3.6%)	0.774
β-blocker use		144 (65.8%)	375 (61.9%)	0.021	111 (66.1%)	112 (67.0%)	0.021
ACE inhibitor use		48 (21.9%)	132 (21.8%)	0.461	37 (22.0%)	135 (22.3%)	0.440
ARB use		66 (30.1%)	153 (25.3%)	0.290	51 (30.4%)	52 (30.9%)	0.271
MRA use		12 (5.5%)	30 (4.9%)	0.001	9 (5.4%)	9 (5.4%)	0.001
Statin use		165 (75.3%)	465 (76.7%)	0.057	127 (75.6%)	128 (76.2%)	0.068

Table 2. The relationship between smoking and LVEF investigated using univariate logistic regression

Variable		Crude OR	(95% CI)	p-value
Smoking	Current smoker		Ref	
	Ex-smoker	1.01	(0.72, 1.41)	0.750

Table 3. The relationship between smoking and LVEF investigated using multiple logistic regression

Variable		Adjusted Logistic regression	(95% CI)	p-value
Smoking	Current smoker		Ref	
	Ex-smoker	1.13	(0.98, 1.29)	0.969

The adjusted confounding variables in model multiple logistic included age, gender, diabetes mellitus, hypertension, hyperlipidemia, prior PCI/CABG, prior MI, prior stroke, aspirin, clopidogrel, warfarin, β-blocker, ACE inhibitor, ARBs, MRAs, and statins

Table 4. Propensity score matching for investigating the relationship between smoking and LVEF

Variable		Propensity score matched	(95% CI)	p-value
Smoking	Current smoker		Ref	
	Ex-smoker	1.02	(0.82,1.22)	0.953

Also, the exposed group had a higher mean LEVF compared to the unexposed group at the follow-up visit, which was not significant. The baseline and follow-up LVEF assessments of both groups are presented in Figure 1.

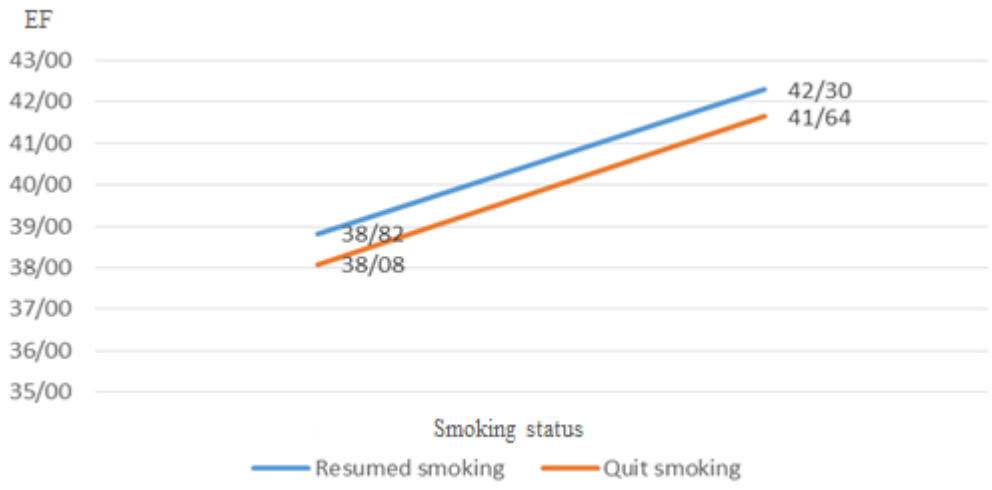

Figure 1. The baseline and follow-up LVEF in both groups.

Discussion

The present study investigated the relationship between smoking and LVEF at the one-year follow-up visit in the patients previously admitted to the Imam Ali Cardiovascular Center, Kermanshah, western Iran, due to STEMI. According to our results, 219 out of 825 patients (26.55%) had quit smoking at the one-year follow-up visit, while 606 out of

825 patients (73.45%) had resumed smoking, which makes these patients at a higher risk for future cardiovascular events.

According to a study by Colivicchi et al. in Italy, 62.8% of patients with Acute Coronary Syndrome (ACS) resumed regular smoking following one year after discharge (12). Moreover, an observational study by Attebring et al. in Sweden reported that 51% of the patients with ACS still smoked 3 months after discharge (13). Another study by Holtrop et al. in Michigan reported that 43.2% of ACS patients resumed regular smoking 8 months after hospital discharge (14). Also, Tabbalat et al. reported that 33%, 30%, and 31% of the patients still smoked following 1, 6, and 12 months from their discharge, respectively (15). It can be hypothesized that smoking cessation at the time of MI-related hospitalization is more likely to be successful because the patients are exposed to high levels of AMI-related stress and potential risks of the revascularization methods. However, this belief is not compatible with the low rate of smoking cessation in the present study. Moreover, it has been shown that new revascularization approaches provided to most STEMI patients, such as primary angioplasty, pharmaco-invasive approach, and thrombolytic therapy, have led to accelerated resolution of chest pain, decreased incidence of life-threatening events, and shorter hospital stay, which may have negatively affected the determination of smokers for smoking cessation (16, 17). Also, the lack of an effective cardiac rehabilitation program and patient-related factors, including gender, socioeconomic status, lower educational level, depression, nicotine dependence, and others, can negatively affect the decision to quit smoking (18).

According to our findings, the prevalence of female smokers was about 4% (33 of 825), showing the remarkably higher popularity of smoking in men. This can be explained by the stigma of smoking for women in Iranian culture. Therefore, the prevalence of smoking in women may have been underestimated in the present study.

Given the high prevalence of smoking in Iran and the relatively younger age of smokers (most of them aged younger than 56 years) admitted with STEMI compared to non-smokers, smoking cessation plays an essential role in primary and secondary prevention of cardiovascular events. Moreover, other cardiovascular risk factors and comorbidities were also prevalent in smokers suffering from AMI in the present study. These comorbidities, including hypertension, diabetes mellitus, and hyperlipidemia, further illustrate the difficulty and multi-dimensional nature of secondary cardiovascular prevention in such a population, highlighting the role of lifestyle modifications and multiple medications.

The results of the multiple logistic regression showed that the OR of reduced LVEF was higher in the unexposed group compared to the exposed group. However, the difference was not significant. Moreover, the OR of reduced LVEF remained higher in the unexposed group compared to the exposed group even after the PSM application. Also, the exposed group had a higher mean LEVF compared to the unexposed group at the follow-up visit, which was not significant. A study by Wei et al. investigated the correlation between smoking and early treatment outcomes in patients with Coronary Artery Bypass Graft (CABG) surgery, reporting a significantly lower LVEF in smokers compared to ex-smokers (19). Moreover, the study by Tabbalat et al. compared persistent smokers and ex-smokers in the one-year outcome following Percutaneous Coronary Intervention (PCI), reporting a higher prevalence of reduced LVEF in ex-smokers compared to persistent smokers (15).

Study Strengths and Limitations

Our study has several limitations as well. First, it is possible that our study design (observational registry) was not fully capable of controlling the effects of confounders due to non-randomization. However, the researchers tried to assess and control the effects of the main confounding factors using the PSM analysis. Moreover, regardless of smoking status, other

differences in post-discharge care may have affected the LVEF of the patients at the one-year follow-up. Also, our data were derived from a single-center registry. Thus, the findings cannot be generalized to other racial/ethnic populations. The present study only illustrated the association between smoking and LVEF at the one-year follow-up in patients with STEMI; we did not provide long-term follow-up data. On the other hand, the present study was the first population-based registry with a large sample in western Iran. Moreover, the patients were evaluated by trained and experienced experts.

Conclusion

The present study showed that about 26% of the MI patients who were smokers had quit smoking at their one-year follow-up visit. Moreover, the OR of reduced LVEF was higher in the ex-smoker groups compared to the current smoker group even after the PSM application. Therefore, given the low rate of smoking cessation after MI, physicians are recommended to ask about the smoking status of MI patients at each office visit or re-admission and strongly recommend quitting smoking. Also, smoking cessation promotion should not be limited to health caregivers. Such an important task should involve the families and government and can be followed by making campaigns, establishing effective anti-smoking laws like taxes on smoking, and others.

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