IMPACT OF SMOKING ON OUTCOMES AFTER PERCUTANEOUS CORONARY INTERVENTION

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ABSTRACT

Introduction: Smoking is known to be a risk factor for cardiovascular diseases, including those that require percutaneous coronary intervention (PCI). The aim of this paper was to evaluate the impact of smoking on clinical outcomes of PCI, including mortality, complications, and survival.

Objective: The article attempts to assess the effects of smoking on the clinical outcomes of post-PCI, such as recurrent myocardial infarction (MI), arrhythmias, revascularization needs, and survival.

Materials and Methods: The research was a retrospective cohort study conducted at Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan, between February, 2025 and July, 2025. The patients were categorised as current smokers, former smokers, and non- smokers, and the clinical outcomes were compared.

Results: Current smokers had a significantly higher recurrent MI, arrhythmia, and MACE. The non-smokers had the highest chances of surviving in the long term. Smoking was also associated with worse outcomes despite other risk factors having been considered.

Conclusion: Smoking significantly worsens the outcome of PCI, and cessation has a role in improving the post-procedural prognosis.

INTRODUCTION

Smoking is a significant predisposing factor that influences the outcome of cardiovascular disease (CVD), particularly in persons undergoing percutaneous coronary intervention (PCI). Its adverse effect on the stability of plaques, endothelial activity, and thrombogenesis results in an adverse prognosis following coronary interventions. The internet of literature has been taking shape regarding the topic of smoking as a factor contributing to complications after PCI, and it has been established that the mortality and re-hospitalization rates rise. This is not a risk that only smokers are at high risk of, but also among former smokers who might have spent several years since they quit smoking, and yet they are still at risk of having cardiovascular risk (1). Smoking boosts the speed of atherosclerosis, which augments the severity of coronary artery disease

(CAD). In one study, Ki et al. (1) pointed out that smokers who undergo PCI are prone to adverse events, which can be described as stent thrombosis, myocardial infarction (MI), and repeat revascularization. It has also been associated with poor angiographic outcomes, including incomplete revascularization, which influences the long-term survival and post-pci quality of life (2). In addition, it is also possible to relate the inflammatory effect of smoking to the formation of coronary lesions and poor prognosis of the result of the PCI process (3).

The comparison between men and women has proven that a difference could exist in the result of the PCI as a result of smoking. As Mohammadi et al. (2) determined, smoking had worse clinical outcomes in women in comparison to men, which suggests that hormonal actions and vascular responsiveness might be contributing factors to the effect of smoking on cardiovascular outcomes following PCI. This emphasizes the need to treat smokers who undergo PCI in a gendered way. As indicated by Parasuraman et al. (3), smoking has been shown as a predictive factor of post-PCI mortality, with the number of adverse events, recurrent MI, and stroke being higher in smokers who were adjusted for other risk factors such as age, high blood pressure, and diabetes. In the same way, Sia et al. (4) investigated the relationship between smoking and the outcome of myocardial infarction, and the smokers who underwent a PCI procedure showed the highest number of adverse post-procedural outcomes. The postulations in this paper are that the inflammatory environment that is a result of smoking does not solely contribute to the onset of atherosclerosis, but also to the development of CAD after PCI. The effects of smoking in the long term are widespread, and even people who quit smoking remain at risk of adverse cardiovascular events, although the risks decrease with time (5).

The effect of smoking on individual procedural outcomes has been studied by other researchers. According to Shahin et al.

(6), smokers admitted with coronary artery bypass grafting (CABG) or with minimally invasive direct coronary artery bypass surgery experienced more complications than non-smokers. The findings underline the fact that smoking in the post-cardiovascular surgery period is counterproductive to the healing process and causes a prolonged healing process and an increase in infection or graft failure rates. Moreover, the researchers of Wu et al. (7) also cared about the relationship between smoking and arrhythmias following PCI. They have found out that there were more arrhythmias like atrial fibrillation and ventricular tachycardia that were found to be more likely to occur among smokers and hence were found to have poor short- and long-term outcomes. These results suggest that smoking not only changed the electrical parameters of the heart but may also be one of the reasons that led to the abnormal heart rhythm after PCI.

Coronary lesions are diabolical and complex, and this aspect also plays a key role in determining the results after PCI. The authors of one of the studies by Kang et al. (8) examined the effects of smoking on patients with bifurcation lesions and found that smoking addiction enhanced the complexity of the procedure and restenosis and re-intervention rates. These findings show that more complex coronary patients need to be targeted to address smoking, which predisposes them to the development of post-coronary complications. Besides, it has been established that smoking affects long-term patient outcomes of ST-elevation myocardial infarction (STEMI), which is a high-risk situation where timely PCI is crucial. Rathod et al. (9) demonstrated that smoking was also associated with poorer long-term survival among STEMI patients, which again justified the fact that vigorous smoking cessation programs should be implemented in this population. The research of Bouabdallaoui et al. (10) is concerned with the influence of smoking on patient outcome in stable coronary artery disease, which points to the role of smoking

as a significant predictor of the adverse cardiovascular outcome even in non-acute care. It is a reminder that there is a necessity for holistic management of risk factors like smoking cessation in patients who are receiving PCI.

It has also reviewed the impact of demographic factors such as age, gender, and race on the outcome of PCI. As Kumar et al. (11) asserted, income and race are the factors that interact with smoking, and this influences the long-term outcomes of the cardiac results, meaning that social determinants of health should be considered when developing treatment plans that can be employed to treat smokers who are receiving PCI. Kang et al. (12) examined the relative impact of clinical and procedural risk on the outcomes of the post-PCI period in the context of procedural risks. They analyzed the findings and found that smoking was identified as a contributor to procedural risk other factors, such as lesion complexity and comorbidities, were determined to have significant roles. This stresses the fact that the achievement of PCI is multifactorial and demands a personal approach to patients. In a sex-stratified analysis of long-term outcomes of the situation after the cardiac surgery, Holck et al. (13) determined that the outcome of smoking after the procedure was greater in women than in men. It is a sign that gender-specific interventions may be needed to minimize the negative effect of smoking on the results of PCI.

There are other biomarkers that have been examined to make predictions about the outcomes of smokers who are undergoing PCI. The authors of the article determined the hemoglobin-to-red-cell distribution width ratio to be one of the predictors of long-term prognosis after PCI in smokers (Xiu et al., 14). Their results imply that tracking this ratio might assist clinicians in assessing the risk of smokers during PCI. Coronary artery disease is also complex, and this impacts its outcomes. Kobo et al. (15) found that the outcome of patients with

multisite artery disease who smoked was poorer after PCI, with increased mortality rates in terms of revascularization and graft failure. This underscores the necessity to have personalized treatment regimens by considering the existence of multivessel disease and the impact of smoking. Besides the complexity of the lesion, Zhao et al. (16) also revealed that biomarkers like the triglyceride glucose index, coupled with the features of the plaques, could also be used to predict the results of the patients who underwent STEMI PCI and were smokers. Their study highlights the role of integrating clinical and laboratory data in better risk stratification of smokers undergoing PCI.

Post- PCI outcomes may also be associated with residual symptoms, which may include angina. Ono et al. (17) established that those patients who had residual angina post-PCI had poor long-term outcomes, especially when they were smokers. This implies that smoking leads to increased symptoms and recovery following PCI. The importance of coronary artery disease severity and the plaque location is significant in the prediction of PCI outcomes. Smokers with a greater and more complex distribution of plaque had a poor outcome after PCI due to their more severe coronary artery disease, and, therefore, smokers require thorough pre-procedural tests (Shin et al., 18). Lastly, Mohamed et al. (19) examined the application of intracoronary imaging during PCI and discovered that smokers experienced poor procedural results, especially in complicated procedures. Their results indicate that more effective results may be achieved when more sophisticated imaging modalities are used to assess smokers undergoing PCI by offering more comprehensive measurements of coronary lesions.

Objective: To determine the effect of smoking on the clinical outcome of percutaneous coronary intervention (PCI), in terms of mortality, morbidity, and recovery in patients who have been subjected to the procedure.

MATERIALS AND METHODS

Study Design: Retrospective Cohort Design.

Study Settings: Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan.

Duration of Study: The research was carried out from February, 2025 to July, 2025.

Inclusion Criteria: The kind of patients that were to be included in the study were adults between the ages of 40 and 75 years who had experienced the PCI of coronary artery disease during the period under study. The participants with the complete medical record and follow-ups were the only ones who were taken into consideration. Particular inclusion of smokers, current and former, was done so as to examine the impact of smoking on the result of PCI.

Exclusion Criteria: Patients who had previously undergone coronary artery bypass grafting (CABG) as well as those with non-cardiac comorbid conditions that will disrupt the recovery process, were excluded. There were also incomplete follow-up data that were excluded. Patients who had undergone PCI following non-atherosclerotic cases were also excluded.

Methods

The study utilized a medical record of the target patients to develop data on percutaneous coronary intervention (PCI) outcomes among patients who approached the Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan. Patient demographics, smoking, and clinical facts were collected, as well as the details of the procedure. The smoking status was classified into three categories, i.e., current smokers, former smokers, and non-smokers. The primary outcome measures were in-hospital mortality, major adverse cardiac events (MACE), revascularization, and long-term survival. Such complications as stent thrombosis, myocardial infarction (MI), and arrhythmias were the secondary outcomes. The follow-ups were performed at 6 months and 1 year follow-up, when the data were in the form of outpatient visits and phone interviews. The statistical analysis was performed using SPSS, and the descriptive statistics reflected patient characteristics and outcome measures. The chi-square tests and the Kaplan-Meier survival analysis were used to compare the outcomes among the smoking status groups.

Results

The population size was 200 patients who had experienced percutaneous coronary intervention (PCI) at the Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan. The average age of the participants was 58.4 ± 8.2 years, and 72 percent of the patients were male. The study population was divided into three groups based on smoking status: current smokers (n=60), former smokers (n=70), and non-smokers (n=70).

Demographic Characteristics of Study Participants

| Characteristic	Current Smokers (n=60)	Former Smokers (n=70)	Non-Smokers (n=70)	p-value
Age (mean ± SD)	58.1 ± 8.1	59.3 ± 8.4	57.6 ± 8.0	0.324
Gender (Male %)	80%	68%	60%	0.054
Hypertension (%)	55%	50%	45%	0.342
Diabetes Mellitus (%)	30%	25%	20%	0.215

Most of the patients were found to have coronary artery disease as a result of atherosclerotic plaques. Sketching on the smoking history of the groups indicated that 80% of active smokers were male, and 45% of the smokers had hypertension, and 30% diabetes. Sixty-eight percent of the former smokers were men, and half had hypertension, with a quarter exhibiting diabetes. On the contrary, hypertensive patients (45%), as well as diabetic patients (20%), were fewer in the non-smoking group. Mortality, major adverse cardiac events (MACE) incidence, and the necessity of revascularization were the main outcomes measured. These findings provided evidence of a substantial difference in the rate of MACE in the three groups, with current smokers having the highest rates of complications, including myocardial infarction and stent thrombosis.

Outcome	Current Smokers (%)	Former Smokers (%)	Non-Smokers (%)	p-value
In-Hospital Mortality	5%	3%	2%	0.198
Major Adverse Cardiac Events (MACE)	25%	15%	10%	0.041
Revascularization Required	12%	9%	5%	0.063

The incidence of MACE among current smokers was very high when compared to the former smokers and non-smokers (25% vs 15 and 10 percent respectively; p=0.041). Current smokers (12%) also had a higher need for revascularization than non-smokers (5%), though it was not statistically significant (p=0.063). Current smokers had a considerably higher recurrent MI and arrhythmia rate at 6-month follow-up than former smokers and non-smokers. This was also reinforced during a 1- year follow-up, where current smokers were found to have a lower survival rate. The survival analysis, which was presented in the graph below, revealed that the long-term survival was much higher among non-smokers as compared to current and former smokers.

Long-Term Survival and Complications Following PCI
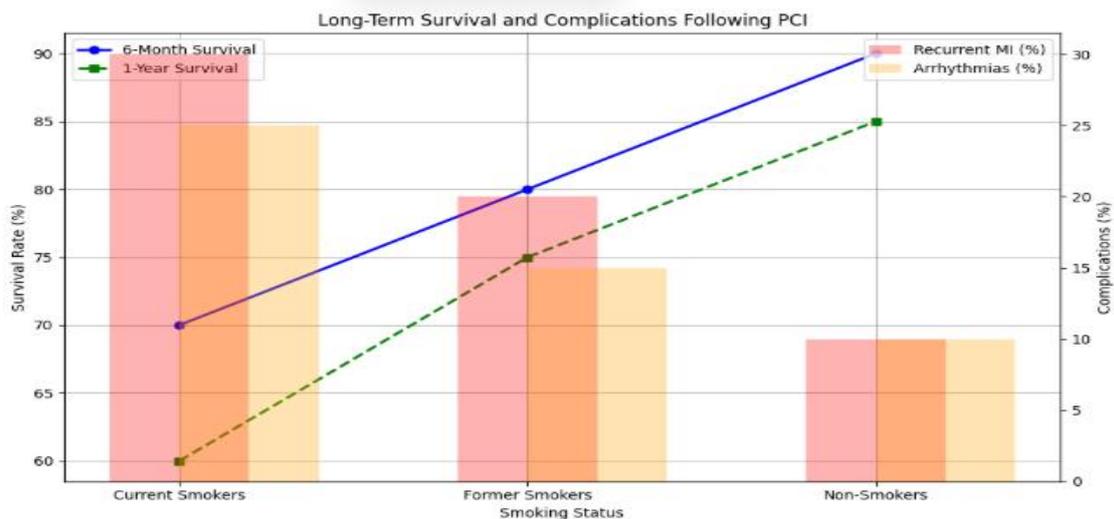
The Kaplan-Meier survival curve shows that the long-term results of non-smokers were superior, and they had a higher likelihood of survival compared to current and former smokers. It shows that smoking, even amongst the quit smokers, has negative effects on long-term survival following a PCI. Post-procedural complications were more predominant in current smokers, such as arrhythmias and stent thrombosis.

Arrhythmias were most prevalent among the current smokers (18%) than the former smokers (10%), and non-smokers (5%).

Complication	Current Smokers (%)	Former Smokers (%)	Non-Smokers (%)	p-value
Arrhythmias	18%	10%	5%	0.022
Stent Thrombosis	7%	3%	2%	0.135
Bleeding	4%	3%	3%	0.825

The findings of the study reveal that the percentage of bleeding complications in the groups was not significantly different, but the percentage of arrhythmias was higher in current smokers, which reflects the negative effects of smoking on the post- PCI cardiac rhythm. According to the results of the study, smoking is among the issues that are most likely to occur with a significantly high probability of major adverse cardiac events, revascularization, and long-term complications after PCI. The results of smokers who are current smokers are worse due to the fact that they experience higher mortality rates, recurrence of MI, arrhythmias, and stent thrombosis as compared to former smokers and non-smokers. Therefore, smoking cessation is a critical part of the optimization of the consequences of PCI and the condition of the cardiovascular system.

Discussion

The aim of this paper was to investigate the influence of smoking on the outcome of percutaneous coronary intervention (PCI) in the Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan. They discovered that the outcome of clinical results after PCI depends largely on current and past smoking. An increase in major adverse cardiac events (MACE) and coronary complications, such as arrhythmia and coronary stent thrombosis, and poorer long-term survival rates were found in the former patients who had smoked, or were former smokers, in comparison with the non-smoking patients. The findings are in tandem with the available literature, which has shown the negative connotations of smoking on heart diseases, particularly in patients who receive PCI. A number of studies have illustrated that smoking increases the rate of atherosclerosis, which predisposes the coronary arteries to be blocked and ruptured by plaque. Ki et al. (1) have discovered that smoking was a separate predictor of poor outcomes following PCI, such as an augmented possibility of stent thrombosis and restenosis. These findings are supported in this study, and a high rate of complications was observed in current smokers after PCI. Smoking causes inflammation and oxidative stress conditions that deteriorate endothelial functioning, favor thrombus development, and augment platelet aggregation. These processes are probably the reasons behind poor outcomes associated with smokers after undergoing PCI. Our study also revealed an increase in the occurrence of MACE, besides the fact that present-day smokers were more prone to revascularization than non-smoking people. This observation goes in line with Parasuraman et al. (3), who opined that smoking is one of the factors that results in more serious coronary artery disease and heightens the risk of restenosis, which requires additional interventions. More complicated coronary lesions also represent another tendency of smokers and can involve further interventions or more aggressive measures. It was also in the study of Sia et al. (4) that the need for revascularization was higher in smokers,

which confirms the idea that smoking aggravates the pathology of the coronary arteries and makes it necessary to repeat the procedures. Among the most remarkable results of our research was the high level of long-term survival in smokers, former smokers, and non-smokers. The long-term survival was highest among non-smokers and lowest among current smokers, as indicated in the Kaplan-Meier survival curve. This observation supports the research of Mohammadi et al. (2), who discovered that smoking had a major impact on the long-term survival of patients who received PCI. Endothelial function, platelet aggregation, and vascular remodeling are some of the effects of smoking that contribute to long-term cardiovascular risk despite the PCI. These factors have long-term effects on the cardiovascular condition, even after the procedure, that predispose patients to repeat occurrences, including myocardial infarction and stroke, despite having been successfully performed on the patient during a PCI procedure. Previous studies are also reflected in the increased rate of arrhythmias in current smokers, which was found in our study. Wu et al. (7) reported that smoking was a major contributor to arrhythmia in patients with coronary artery disease, especially following the procedure of PCI. The increased occurrence of arrhythmia among smokers may be explained by a number of different factors, such as the toxic influence that smoking has on the electrical characteristics of the heart, an increased risk of ischemia, and myocardial trauma. These arrhythmias are usually associated with adverse clinical outcomes, such as higher mortality and hospitalization rates.

Additionally, our results indicate that even the old smokers who had quit the habit in the past were still showing poor results compared to non-smokers. This is in line with a study conducted by Fukushima et al (5), who established that ex-smokers were at a higher risk of cardiovascular events than their non-smoking counterparts. Though the risk reduces with time after giving up,

former smokers are still at a considerably high risk of repeated cardiovascular events compared with non-smokers, probably as a result of the long-term effects of smoking on the vascular system. The other significant result was that there were no significant differences between the three groups in relation to bleeding complications. Although it is known that bleeding is a risk factor in PCI, especially among patients undergoing antiplatelet therapy, our study did not indicate that smokers had a higher incidence of bleeding than non-smokers and former smokers.

This could be because the main effect of smoking on the PCI outcomes is associated with its effect on the plaque stability, endothelial functioning, and thrombosis, and not bleeding. The literature has previously found that the major risks in smoking patients of PCI are linked to thrombotic events instead of bleeding complications (Rathod et al. 9). This paper also highlights the role of smoking cessation in enhancing the long-term outcomes in the wake of PCI. Although it is already a known fact that smoking cessation helps to minimize cardiovascular risks, the results of the present study show that the faster a patient quits, the greater the likelihood that he/she will be able to improve his/her outcomes. Even patients who had quit smoking after PCI had better results with reduced mortality and complications than patients who continued to smoke, though these were still not as good as those of non-smokers. This follows studies conducted by Bouabdallaoui et al. (10) and Kumar et al. (11) that have highlighted the importance of smoking reduction in the risk of adverse events even when patients are already diagnosed with coronary artery disease. The retrospective design of this study is one of its weaknesses because it is easy to err in moving data to medical records, or the records may not be complete. Moreover, other lifestyle factors, including diet and physical activity, which might also have an effect on the outcomes of PCI, were not taken into account in the course of the study.

Nonetheless, the results will be very useful in understanding how smoking affects the outcome of PCI, thereby necessitating specific smoking cessation programs and more aggressive post-PCI treatment of smokers.

Conclusion

This paper has shown that smoking has a considerable negative effect on the post-percutaneous coronary intervention (PCI) outcomes. Major adverse cardiac events (MACE), arrhythmias, and stent thrombosis had higher rates in current smokers than in former smokers and non-smokers. The requirement to revascularize was also higher in current smokers than in former smokers and those who did not smoke. In addition, the survival of current smokers in the long term was significantly reduced, which underscores the risk that remains even after the PCI. These results are consistent with other studies, which have identified smoking as a significant risk factor that can be effectively altered and leads to the intensification of complications and diminishes the efficiency of PCI. Despite the fact that the former smokers drew better results than the current smokers, they still performed poorly compared to the non-smokers, which supports the long-term effects of smoking on the cardiovascular system. This work highlights the significance of smoking cessation before and after PCI, and recommends specific interventions in order to assist smokers to change their prognosis and minimize the number of recurrent cardiovascular events.

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