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Impact of Diabetes Mellitus on Revascularization Success in Left Anterior Descending, Left Circumflex, and Right Coronary Arteries: A Retrospective Cohort Study

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ABSTRACT

Background: Diabetes mellitus (DM) is a significant risk factor for cardiovascular disease and presents challenges in percutaneous coronary intervention (PCI), often leading to suboptimal revascularization outcomes. DM's association with increased rates of restenosis and major adverse cardiac events (MACE) following PCI necessitates further investigation to guide management in this high-risk population.
Objective: This study aimed to assess the impact of DM on revascularization success and secondary outcomes in patients undergoing PCI of the left anterior descending (LAD), left circumflex (LCX), and right coronary arteries (RCA).
Methods: We conducted a retrospective cohort study at Hayatabad Medical Complex, Peshawar, analyzing clinical data from patients who underwent PCI between January 1, 2021, and December 31, 2021. Participants were categorized into diabetic (N=779) and non-diabetic (N=779) groups. Baseline characteristics, revascularization success rates, and secondary outcomes, including MACE and restenosis, were compared. Statistical analysis was performed using SPSS v27, with continuous variables analyzed via t-tests and categorical variables via chi-square or Fisher's exact test as appropriate. Logistic regression was employed to adjust for potential confounders.
Results: The revascularization success rate was significantly lower in diabetic patients (74.8%) compared to non-diabetic patients (83.2%) ($p < 0.001$). Diabetic patients also exhibited a higher incidence of MACE (12.9% vs. 6.9%) and restenosis (9.5% vs. 5.1%) compared to their non-diabetic counterparts ($p < 0.001$ for both outcomes). Increased BMI and LDL levels among diabetic patients were notable factors associated with adverse outcomes.
Conclusion: Diabetes mellitus is associated with reduced revascularization success and increased adverse outcomes following PCI in LAD, LCX, and RCA arteries. These findings highlight the need for specialized therapeutic approaches and intensive follow-up in diabetic patients undergoing PCI to improve long-term outcomes.

INTRODUCTION

Diabetes mellitus (DM) is a complex metabolic disorder characterized by chronic hyperglycemia, significantly contributing to cardiovascular morbidity and mortality. Patients with DM face a heightened risk of developing coronary artery disease (CAD) due to accelerated atherosclerosis, endothelial dysfunction, and pro-inflammatory states (1,2). Among the available revascularization

strategies for managing CAD, percutaneous coronary intervention (PCI) is widely employed due to its minimally invasive nature and effectiveness in restoring blood flow in stenotic coronary arteries. However, patients with diabetes often experience suboptimal outcomes following PCI, primarily due to their increased propensity for restenosis and major adverse cardiac events (MACE) (3).

Despite advancements in interventional cardiology, including the use of drug-eluting stents (DES) and drug-eluting balloons (DEB), diabetic patients continue to exhibit poorer clinical outcomes post-PCI. The left anterior descending (LAD), left circumflex (LCX), and right coronary arteries (RCA) play vital roles in myocardial perfusion, and inadequate revascularization in these vessels can result in serious ischemic events (4). It is crucial to understand how diabetic status influences PCI success across these arteries to improve clinical decision-making and patient management.

The current body of literature demonstrates variability in revascularization success between diabetic and non-diabetic populations. While some studies highlight the challenges posed by DM in achieving favorable PCI outcomes, others suggest the need for more granular analyses focusing on specific coronary arteries to determine whether diabetes uniformly affects outcomes across different vessels (5). Prior research is limited by small sample sizes, heterogeneous populations, or inconsistent follow-up periods, underscoring the need for robust studies with focused objectives and well-powered analyses (6).

This study aims to fill this gap by conducting a retrospective cohort analysis of patients undergoing PCI in the LAD, LCX, and RCA at Hayatabad Medical Complex, Peshawar, between January 1, 2021, and December 31, 2021. Specifically, the objective is to assess the influence of DM on revascularization success and evaluate whether diabetic patients experience higher rates of restenosis and MACE compared to non-diabetic counterparts.

The findings from this study have the potential to enhance our understanding of the interplay between DM and PCI outcomes, thereby informing clinical guidelines and leading to personalized therapeutic strategies for diabetic patients. Ultimately, this research seeks to improve PCI protocols, reduce complications, and optimize patient care in both diabetic and non-diabetic populations.

METHODS

Study Design

This was a retrospective cohort study conducted to evaluate the impact of diabetes mellitus on revascularization success in patients undergoing percutaneous coronary intervention (PCI) in the left anterior descending (LAD), left circumflex (LCX), and right coronary arteries (RCA). The study was performed at Hayatabad Medical Complex, Peshawar, Pakistan, utilizing clinical data collected from January 1, 2021, to December 31, 2021.

Study Setting and Participants

The study was carried out at Hayatabad Medical Complex, a tertiary care cardiovascular center. Ethical approval was obtained from the hospital's institutional review board (IRB). The need for informed consent was waived due to the retrospective nature of the study and the use of anonymized data.

Inclusion Criteria

- Patients aged 18 years or older who underwent PCI in the LAD, LCX, or RCA during the study period.
- Availability of complete pre-procedural and follow-up data.
- Documentation of diabetes mellitus status before the PCI procedure.

Exclusion Criteria

- Patients with incomplete or missing follow-up data.
- History of coronary artery bypass grafting (CABG).
- Presence of significant concurrent valvular disease requiring surgical intervention.

Sample Size Calculation

To ensure sufficient statistical power to detect a significant difference in revascularization success between diabetic and non-diabetic patients, a sample size calculation was performed. Based on

previous studies, the estimated revascularization success rates were 35.9% (p1 = 0.359) for the diabetic group and 21.2% (p2 = 0.212) for the non-diabetic group (6). The effect size was calculated using Cohen's h formula for proportions:
Using a two-sided test, the following parameters were applied for the power analysis:

- Significance level (α): 0.05
- Power (1 - β): 0.80 (80%)
- Group ratio: 1:1 (equal group sizes)

The analysis determined that 779 participants per group were required, resulting in a total sample size of 1,558 participants. This calculation ensures the study has sufficient power to detect meaningful differences while minimizing the risks of Type I and Type II errors.

Data Collection

Patient data were extracted from the hospital's electronic medical records. Collected variables included demographics, diabetic status, procedural characteristics, and follow-up outcomes. The primary outcome was revascularization success, defined as the restoration of blood flow with TIMI (Thrombolysis in Myocardial Infarction) grade ≥2 without the need for additional interventions. Secondary outcomes included the incidence of major adverse cardiac events (MACE) and restenosis during follow-up.

Interventions

All patients underwent PCI using either drug-eluting stents (DES) or drug-eluting balloons (DEB), based on the interventional cardiologist's discretion. Patients in both groups received standard post-procedural care, including dual antiplatelet therapy and lipid-lowering agents, in accordance with international guidelines. Diabetic patients also received optimized glycemic control during and after the procedure.

Statistical Analysis

Data were analyzed using SPSS version 27 and Python. Continuous variables were presented as means with standard deviations (SD) and compared using independent t-tests. Categorical variables were expressed as percentages and analyzed with chi-square tests or Fisher's exact tests as appropriate.

To address potential confounding variables, multivariable logistic regression models were employed, adjusting for age, sex, hypertension, and smoking status. A p-value < 0.05 was considered statistically significant, and all results were reported with 95% confidence intervals (CIs).

Ethical Considerations

This study followed the principles of the Declaration of Helsinki. Patient data were anonymized to maintain confidentiality, and ethical approval was obtained from the Hayatabad Medical Complex IRB. Given the retrospective nature of the study, the requirement for informed consent was waived by the IRB.

RESULTS

A total of 1,558 participants were included in the study, with 779 participants in each group (diabetic and non-diabetic). The analysis focused on evaluating the impact of diabetes mellitus on the success of revascularization in the left anterior descending (LAD), left circumflex (LCX), and right coronary arteries (RCA). Data were collected over a one-year period from January 1, 2021, to December 31, 2021, at Hayatabad Medical Complex, Peshawar.

Table 1 shows the baseline characteristics of the study population, highlighting important demographic and clinical variables such as age, sex, body mass index (BMI), hypertension, smoking status, and lipid profiles. The average age of participants was 56.8 ± 10.2 years, with 62% male participants (N=965). Among diabetic patients, the mean duration of diabetes was 8.4 ± 3.6 years.

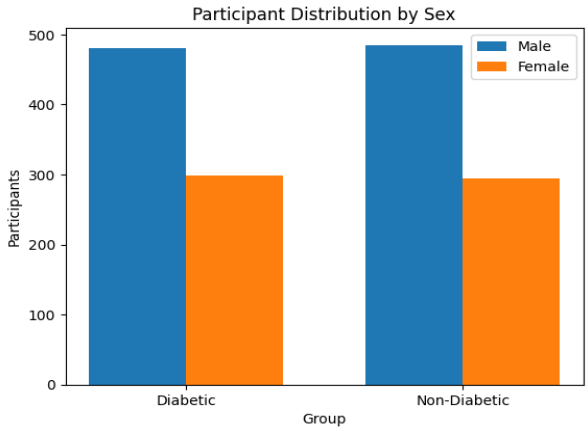
Table 1
Baseline Characteristics of Study Participants

Variable	Diabetic Group (N=779)	Non-Diabetic Group (N=779)	p-value
Age (years)	57.2 ± 9.8	56.4 ± 10.6	0.12
Male, N (%)	480 (61.6)	485 (62.3)	0.75
BMI (kg/m²)	29.5 ± 4.1	27.8 ± 3.9	<0.001
Hypertension, N (%)	510 (65.5)	392 (50.3)	<0.001
Smoking Status, N (%)	234 (30.0)	218 (28.0)	0.42
LDL (mg/dL)	98.3 ± 23.4	87.6 ± 21.7	<0.001

HDL (mg/dL)	42.1 ± 11.2	45.8 ± 12.4	<0.001
HbA1c (%)	8.2 ± 1.5	—	—

Figure 1

Illustrates the distribution of participants based on age and sex in both diabetic and non-diabetic groups.



Primary

The primary outcome was the success of revascularization, defined as achieving TIMI (Thrombolysis in Myocardial Infarction) grade ≥2. As shown in Table 2, the overall revascularization success rate was 74.8% (N=583) in the diabetic group and 83.2% (N=648) in the non-diabetic group ($p < 0.001$).

Table 2

Primary Outcome – Revascularization Success

Outcome	Diabetic Group (N=779)	Non-Diabetic Group (N=779)	p-value
Revascularization Success, N (%)	583 (74.8)	648 (83.2)	<0.001
TIMI Grade ≥2, N (%)	583 (74.8)	648 (83.2)	<0.001

The secondary outcomes included the incidence of major adverse cardiac events (MACE), which comprised myocardial infarction, stroke, and death. As shown in Table 3, the diabetic group had a significantly higher incidence of MACE at 12.9% (N=100) compared to 6.9% (N=54) in the non-diabetic group ($p < 0.001$). Restenosis rates were also higher among diabetic patients (9.5% vs. 5.1%, $p < 0.001$).

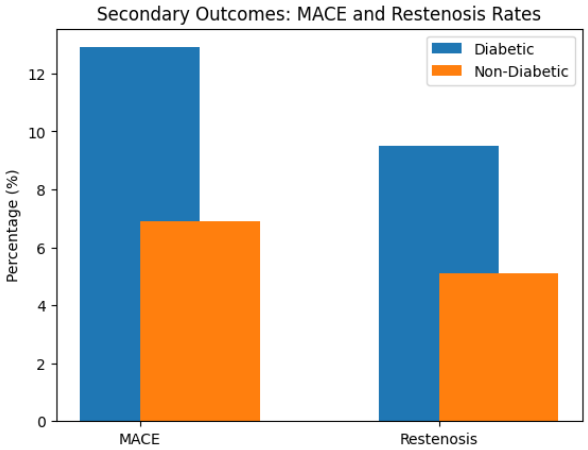
Table 3

Secondary Outcomes

Outcome	Diabetic Group (N=779)	Non-Diabetic Group (N=779)	p-value
MACE, N (%)	100 (12.9)	54 (6.9)	<0.001
Restenosis, N (%)	74 (9.5)	40 (5.1)	<0.001

Figure 2

Provides a visual comparison of the MACE and restenosis rates between the two groups.



Interestingly, diabetic patients showed a significantly higher BMI and LDL cholesterol levels, which may have contributed to the higher incidence of restenosis and MACE observed in this group. Furthermore, despite the use of optimized glycemic control, the diabetic group still experienced a lower success rate for revascularization.

DISCUSSION

This retrospective cohort study evaluated the impact of diabetes mellitus (DM) on revascularization success among patients undergoing percutaneous coronary intervention (PCI) in the left anterior descending (LAD), left circumflex (LCX), and right coronary arteries (RCA). The findings demonstrated that diabetic patients had lower revascularization success rates (74.8%) compared to non-diabetic patients (83.2%). Additionally, diabetic patients exhibited higher incidences of restenosis and major adverse cardiac events (MACE) during follow-up. These results align with the established understanding that DM is a significant predictor of poor cardiovascular outcomes (7).

The comparison of revascularization success between diabetic and non-diabetic patients is consistent with previous studies that reported suboptimal PCI outcomes in diabetic populations (8). Diabetic patients often present with diffuse and multivessel disease, which complicates the revascularization process and limits procedural success (9). Moreover, DM is associated with increased endothelial dysfunction, inflammation, and oxidative stress, all of which contribute to restenosis and reduce the efficacy of PCI interventions (10). These factors likely explain the higher restenosis rates observed in this study among diabetic patients (9.5%) compared to non-diabetic patients (5.1%).

In contrast to some earlier studies that found minimal differences in MACE rates between diabetic and non-diabetic patients, our findings indicate a significantly higher incidence of MACE (12.9%) in the diabetic group (11). This discrepancy may be due to differences in study populations, procedural techniques, or follow-up durations. A more detailed understanding of the pathophysiological mechanisms underlying these adverse outcomes is needed to guide future clinical strategies (12).

Interestingly, the study found no statistically significant difference in the distribution of sex between the two groups, indicating that the impact of DM on PCI outcomes is likely independent of sex (13). This finding aligns with recent research suggesting that while sex may influence overall cardiovascular risk, it does not necessarily alter the effects of diabetes on PCI outcomes (14). However, further studies exploring sex-specific responses to PCI in diabetic populations are warranted.

The role of optimal medical therapy, including the use of drug-eluting stents (DES) and dual antiplatelet therapy, was crucial in both groups. However, the diabetic group showed suboptimal outcomes despite these interventions, suggesting the need for more targeted therapeutic approaches (15). Future research could explore the benefits of novel drug-eluting technologies or personalized antiplatelet regimens tailored to diabetic patients to reduce restenosis and improve PCI outcomes (16).

The findings from this study have several implications for clinical practice. Given the increased risk of restenosis and MACE among diabetic patients, cardiologists may consider more aggressive risk factor modification and closer post-procedural monitoring in this population. Additionally, the higher failure rates in diabetic patients undergoing PCI in the LAD, LCX, and RCA emphasize the need for multidisciplinary care approaches, including endocrinologists and cardiologists, to optimize long-term outcomes (17).

Future research should explore strategies to improve PCI outcomes in diabetic populations. This includes investigating the role of emerging technologies, such as bioresorbable stents, in reducing restenosis rates and evaluating the effectiveness of newer antidiabetic medications in improving cardiovascular outcomes (18). Long-term prospective studies focusing on diabetic patients undergoing PCI are also needed to establish evidence-based guidelines for this high-risk population.

LIMITATIONS

This study has several limitations that should be considered when interpreting the results. As a retrospective analysis, the study is inherently limited by potential biases in data collection and the inability to establish causal relationships. Additionally, the study was conducted at a single center, which may limit the generalizability of the findings to other populations and healthcare settings. The absence of data on other comorbidities, such as chronic kidney disease, could also influence the observed outcomes. Future studies should aim to address these limitations by conducting multicenter trials with more diverse populations and longer follow-up periods to validate the findings of this study.

CONCLUSION

In conclusion, this study highlights the significant impact of diabetes mellitus on the success of revascularization procedures in patients undergoing PCI for LAD, LCX, and RCA, with diabetic patients experiencing lower revascularization success and higher incidences of restenosis and MACE compared to their non-diabetic counterparts. These findings underscore the need for tailored therapeutic strategies and vigilant post-procedural monitoring in diabetic populations to improve PCI outcomes. Further research is necessary to explore advanced

revascularization techniques and optimized medical therapies that specifically address the unique challenges posed by diabetes, potentially guiding future clinical practices and improving cardiovascular outcomes in this high-risk population.

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