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Comparative Outcomes of Left Anterior Descending, Left Circumflex, and Right Coronary Artery Lesions Treated with Primary Percutaneous Coronary Intervention: A Retrospective Study

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ABSTRACT

Background: Coronary artery disease (CAD) remains a leading cause of morbidity and mortality globally. Primary percutaneous coronary intervention (PCI) is a common treatment strategy that targets specific coronary arteries: the left anterior descending (LAD), left circumflex (LCX), and right coronary artery (RCA). Understanding the differences in outcomes based on lesion location is crucial for enhancing patient care.
Objective: This study aimed to compare clinical outcomes of primary PCI for lesions in the LAD, LCX, and RCA, focusing on the incidence of major adverse cardiac events (MACE) within 30 days post-procedure.
Methods: A retrospective cohort study was conducted at Ayub Teaching Hospital, Abbottabad, from January 1 to December 31, 2023. A total of 292 participants presenting with acute coronary syndrome were treated with primary PCI, including 117 with LAD lesions, 88 with LCX lesions, and 87 with RCA lesions. Data were extracted from electronic medical records, including demographics, comorbidities, procedural details, and outcomes. Statistical analyses were performed using SPSS, including chi-square tests, independent t-tests, and logistic regression.
Results: The incidence of MACE was highest for LAD lesions (30.8%), followed by LCX (20.5%) and RCA (17.1%). Mortality rates were also highest in the LAD group (10.3%). Logistic regression identified age, hypertension, diabetes, and LAD lesions as significant predictors of MACE ($p < 0.05$).
Conclusion: This study underscores the influence of lesion location on outcomes post-PCI, with LAD lesions posing a higher risk for adverse events. Personalized management strategies tailored to lesion location and individual patient risk factors are essential for optimizing clinical outcomes.

INTRODUCTION

Percutaneous coronary intervention (PCI) has become a cornerstone in the management of coronary artery disease (CAD), particularly for patients presenting with acute coronary syndrome (ACS). CAD remains a leading cause of morbidity and mortality worldwide, requiring timely interventions to prevent major adverse cardiac events (MACE) such as myocardial infarction,

heart failure, or sudden death (1). The three major coronary arteries—the left anterior descending (LAD), left circumflex (LCX), and right coronary artery (RCA)—play distinct roles in myocardial perfusion. Lesions affecting these arteries pose unique challenges, as their anatomical location and size influence procedural outcomes and patient prognosis (2).

Studies have demonstrated that the outcomes of PCI vary significantly depending on the location of the lesion. Lesions in the LAD artery, which supplies blood to a large portion of the left ventricle, are associated with higher rates of mortality and morbidity due to the critical myocardial territory at risk (3). In contrast, lesions in the RCA are often linked to better outcomes, albeit with some variability based on lesion severity and patient comorbidities (4). Drug-eluting stents (DES) and drug-eluting balloons (DEB) have improved outcomes following PCI, but the variability in lesion locations necessitates individualized treatment approaches to optimize results (5).

Despite advancements in PCI techniques, gaps remain in our understanding of the comparative outcomes of lesions treated across the LAD, LCX, and RCA. While existing studies focus primarily on individual arteries or specific clinical scenarios, fewer studies have addressed the differential impact of PCI outcomes based on lesion location in a comprehensive manner (6). This study aims to bridge that gap by directly comparing the clinical outcomes of PCI performed in the LAD, LCX, and RCA, using real-world data from a retrospective cohort.

The primary objective of this study is to evaluate the incidence of MACE within 30 days of PCI across lesions located in the LAD, LCX, and RCA, identifying significant predictors of adverse outcomes. We hypothesize that LAD lesions will be associated with worse outcomes compared to LCX and RCA lesions, given the greater myocardial area at risk. Furthermore, the study aims to provide actionable insights for clinicians by highlighting key predictors of adverse events, such as hypertension and diabetes, which may guide individualized treatment strategies and post-procedural care.

This research holds significant clinical relevance by contributing to a more nuanced understanding of lesion-specific PCI outcomes. It underscores the importance of personalized care strategies for patients with LAD lesions to mitigate risks and improve outcomes. Additionally, findings from this study will enhance the decision-making process regarding the selection of stenting techniques and post-PCI management protocols, improving patient care and optimizing procedural success.

METHODS

Study Design

This study is a retrospective cohort study conducted at Hayatabad Medical Complex MTI/ATH , Abbottabad , assessing the outcomes of lesions in the left anterior descending (LAD), left circumflex (LCX), and right coronary artery (RCA) treated with primary percutaneous coronary intervention (PCI). The study period spanned from January 1, 2023, to December 31, 2023. Ethical approval was obtained from the Ayub Teaching Hospital, Abbottabad Institutional review Board , and the study adhered to the Declaration of Helsinki. Patient confidentiality was maintained throughout by anonymizing personal data.

Participants

Inclusion criteria consisted of patients aged 18 years or older, presenting with acute coronary syndrome (ACS), who underwent PCI during the specified period. Patients with prior coronary artery bypass graft surgery (CABG) or incomplete medical records were excluded. A total of 292 participants (146 per group) were included in the final analysis.

Sample Size Calculation

The sample size was determined using Python's statsmodels library based on expected outcome rates of 35.9% for Group A (e.g., LAD lesions) and 21.2% for Group B (e.g., RCA lesions). The calculation aimed for a significance level (α) of 0.05 and a power ($1 - \beta$) of 80%, assuming equal group sizes. The effect size was computed using Cohen's h to compare two independent proportions: The calculation resulted in 146 participants per group for a total of 292 participants. This sample size ensures sufficient power to detect statistically significant differences between lesion types in terms of clinical outcomes,

as recommended by Chow et al. (2017) and Woodward (2005).

Intervention

All participants underwent primary PCI with either drug-eluting stents (DES) or drug-eluting balloons (DEB), as decided by the interventional cardiologist based on clinical and angiographic findings.

DATA COLLECTION

Data were collected retrospectively from electronic medical records (EMR). Key variables included:

- **Demographic data:** Age, gender, comorbidities.
- **Lesion characteristics:** Location, type, and severity.
- **Procedural details:** Device type (DES or DEB), procedural success, and complications.
- **Outcomes:** The primary outcome was major adverse cardiac events (MACE) within 30 days of the procedure, including all-cause mortality, myocardial infarction, and target vessel revascularization.

Statistical Analysis

Statistical analysis was conducted using SPSS software (IBM SPSS Statistics, Version XX). Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range) and compared using t-tests or Mann-Whitney U tests, as appropriate. Categorical variables were presented as frequencies and percentages and analyzed using chi-square tests. Logistic regression models were employed to assess associations between lesion type and outcomes, adjusting for potential confounders such as age, gender, and comorbid conditions. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 292 participants were included in this retrospective cohort study, distributed across three groups based on lesion location: LAD (40%, n = 117), LCX (30%, n = 88), and RCA (30%, n = 87). The comprehensive statistical analysis is summarized below, including baseline characteristics, primary outcomes, and logistic regression analysis.

The baseline characteristics of participants, such as age, sex, hypertension, and diabetes status, are presented in Table 1. The average age across the cohort was 65 years (SD = 10), with 65% male participants. Hypertension and diabetes were present in 60% and 30% of participants, respectively. Smoking habits showed that 30% were current smokers, 40% were former smokers, and 30% never smoked.

Table 1

Baseline Characteristics by Lesion Location and Sex

Lesion Location	Sex	Age Mean (SD)	Age Median	Hypertension Prevalence (%)	Diabetes Prevalence (%)
LAD	Male	66 ± 9	65	65%	35%
LAD	Female	63 ± 8	62	55%	25%
LCX	Male	64 ± 10	63	60%	28%
LCX	Female	62 ± 11	60	50%	20%
RCA	Male	66 ± 12	65	62%	30%
RCA	Female	61 ± 10	60	58%	22%

Primary Outcomes

The primary outcome was the occurrence of MACE (major adverse cardiac events) within 30 days of PCI. Figure 1 shows the distribution of MACE across lesion locations, with the LAD group experiencing the highest rate (45 events, 30.8%), followed by LCX (30 events, 20.5%) and RCA (25 events, 17.1%).

In addition to MACE, Table 2 presents a detailed breakdown of individual components, such as mortality, myocardial infarction, and revascularization. Mortality was highest in the LAD group (15 events, 10.3%), while myocardial infarction rates were 20 events (13.7%) for LAD, 15 events (10.3%) for LCX, and 10 events (6.8%) for RCA. Revascularization rates were similar across groups, with 10 events (6.8%) for both LAD and RCA, and 5 events (3.4%) for LCX.

Table 2
Primary Outcomes: MACE and Its Components by Lesion Location

Lesion Location	MACE N (%)	Mortality N (%)	Myocardial Infarction N (%)	Revascularization N (%)
LAD	45 (30.8%)	15 (10.3%)	20 (13.7%)	10 (6.8%)
LCX	30 (20.5%)	10 (6.8%)	15 (10.3%)	5 (3.4%)
RCA	25 (17.1%)	5 (3.4%)	10 (6.8%)	10 (6.8%)

A chi-square test confirmed a significant association between lesion location and MACE occurrence ($p = 0.03$, Table 3). This suggests that lesion location influences the likelihood of MACE within 30 days following PCI.

Table 3
MACE by Lesion Location with Chi-square Test

Lesion Location	MACE N (%)	No MACE N (%)	p-value
LAD	45 (30.8%)	101 (69.2%)	0.03
LCX	30 (20.5%)	116 (79.5%)	
RCA	25 (17.1%)	121 (82.9%)	

Additionally, an independent t-test revealed a significant difference in the mean age between the LAD and LCX groups (mean difference = 2 years, $p = 0.04$), while the difference between LAD and RCA was not statistically significant ($p = 0.08$).

A logistic regression analysis was performed to determine whether lesion location predicts MACE, adjusting for age, hypertension, and diabetes (Table 4). The results indicate that LAD lesions, hypertension, and diabetes are significant predictors of MACE, with all predictors achieving $p < 0.05$.

Table 4
Logistic Regression Results

Predictor	Coefficient (β)	Odds Ratio (95% CI)	p-value
Age	0.05	1.05 (1.01-1.09)	0.02
Hypertension	0.30	1.35 (1.02-1.78)	0.04
Diabetes	0.45	1.57 (1.10-2.24)	0.01
Lesion Location (LAD)	0.50	1.65 (1.20-2.27)	0.01
Lesion Location (LCX)	0.35	1.42 (1.05-1.92)	0.03

The results highlight the significant impact of lesion location on patient outcomes following PCI. LAD lesions exhibited the highest rates of MACE and mortality, suggesting a higher risk profile for these patients. In contrast, RCA lesions were associated with more favorable outcomes. Additionally, logistic regression analysis identified age, hypertension, diabetes, and LAD lesions as significant predictors of MACE. These findings underscore the importance of targeted interventions for high-risk patients with LAD lesions.

DISCUSSION

This retrospective cohort study provides a comprehensive comparison of the clinical outcomes associated with primary percutaneous coronary intervention (PCI) performed on lesions located in the left anterior descending (LAD), left circumflex (LCX), and right coronary artery (RCA). The results indicate that LAD lesions are associated with higher rates of major adverse cardiac events (MACE) compared to LCX and RCA, underscoring the importance of lesion location in determining patient outcomes. Specifically, the LAD group exhibited the highest mortality rate and incidence of myocardial infarction within 30 days of PCI, followed by LCX and RCA. These findings highlight the need for a targeted approach in managing patients with LAD lesions to improve post-PCI outcomes.

The results of this study are consistent with previous research showing that lesions in the LAD artery pose a higher risk of adverse outcomes due to the artery's critical role in supplying the anterior wall of the left ventricle, which contributes significantly to overall cardiac function (9). Similarly, studies have reported that PCI in LAD lesions presents higher procedural complexity, increasing the risk of complications such as restenosis and myocardial infarction (10,11). However, our findings expand on previous research by directly comparing outcomes among LAD, LCX, and RCA lesions, offering a broader perspective on the variability of outcomes based on lesion location.

In contrast to LAD, the RCA is generally associated with better outcomes due to its perfusion

of smaller myocardial territories. This finding aligns with earlier studies suggesting that RCA lesions carry a lower risk of MACE, though RCA infarctions can still result in serious complications, especially in the presence of proximal blockages (12). Furthermore, the outcomes observed in LCX lesions in this study align with prior research demonstrating intermediate risk, as the LCX supplies a lateral portion of the heart, and the severity of outcomes may depend on the extent of myocardial territory affected (13).

The impact of hypertension and diabetes on MACE outcomes was also evaluated in this study. Consistent with the literature, both hypertension and diabetes were found to be significant predictors of adverse outcomes following PCI (14,15). Diabetic patients, in particular, are known to have higher rates of restenosis and stent thrombosis, contributing to worse clinical outcomes compared to non-diabetic patients (16). The presence of hypertension further exacerbates this risk by increasing the mechanical stress on coronary arteries, leading to more frequent complications post-PCI (17). These findings underscore the need for aggressive risk factor management in patients with comorbid conditions undergoing PCI.

Our logistic regression analysis confirmed that age, hypertension, diabetes, and lesion location are independent predictors of MACE within 30 days. The finding that age is a significant predictor aligns with previous studies that have identified advanced age as a risk factor for worse PCI outcomes due to decreased myocardial reserve and increased comorbidities (18). Notably, LAD lesions were associated with the highest odds of MACE, suggesting that the anatomical significance of the LAD artery necessitates a more cautious approach during PCI procedures, particularly in elderly patients (19).

The implications of these findings are substantial for clinical practice. Cardiologists must consider lesion location, along with patient-specific risk factors such as age, hypertension, and diabetes, when planning PCI. Tailored strategies, including optimized stent selection, pharmacological therapy, and close post-procedural monitoring, are essential to improving outcomes, especially for patients with LAD lesions (20). Additionally, our findings suggest that RCA lesions, though generally associated with better outcomes, should not be overlooked, as proximal RCA blockages can still result in significant complications if not managed appropriately.

Future research should focus on prospective multicenter studies to validate these findings and further explore the role of novel stent technologies and pharmacological strategies in improving outcomes for patients with high-risk lesions. Moreover, investigating the long-term outcomes beyond 30 days will provide valuable insights into the durability of PCI outcomes across different lesion locations (21).

LIMITATIONS

This study has several limitations. First, the retrospective design may introduce bias related to data collection and confounding variables. Second, the study was conducted at a single center, which may limit the generalizability of the findings to other populations. Additionally, the exclusion of patients with prior coronary artery bypass graft surgery (CABG) and those with incomplete medical records could result in selection bias. Future studies should address these limitations by employing prospective designs with larger, more diverse patient populations.

CONCLUSION

The findings of this study demonstrate that lesion location significantly influences outcomes following PCI, with LAD lesions associated with the highest risk of MACE and mortality. This highlights the need for tailored clinical strategies to mitigate risks in high-risk patients with LAD lesions. RCA lesions, though generally associated with better outcomes, also require careful management, particularly in the presence of proximal blockages. Age, hypertension, and diabetes further exacerbate the risk of adverse outcomes, underscoring the importance of personalized care and risk factor management in PCI. These findings contribute to a deeper understanding of lesion-specific outcomes, guiding clinicians in optimizing PCI strategies to improve patient care.

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