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Original Article

Percutaneous Coronary Intervention versus Coronary Artery Bypass Grafting for Chronic Total Occlusion of Coronary Arteries

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ABSTRACT

Background: Chronic Total Occlusion (CTO) of coronary arteries presents a significant challenge in the management of coronary artery disease (CAD), influencing treatment outcomes and patient prognosis. Percutaneous Coronary Intervention (PCI) and Coronary Artery Bypass Grafting (CABG) are two predominant revascularization strategies employed, each offering distinct benefits and limitations.

Objective: This study aims to compare the efficacy and safety of PCI and CABG in managing patients with CTO, to inform clinical decision-making and optimize treatment approaches.

Methods: A retrospective analysis was conducted at Lady Reading Hospital, Peshawar, from January 1, 2021, to December 31, 2023. We included 145 patients diagnosed with CTO who underwent PCI (n=65) or CABG (n=80). Data were collected on patient demographics, clinical features, lesion characteristics, procedural details, and follow-up outcomes. Major Adverse Cardiac Events (MACE) and quality of life measures were the primary endpoints. Statistical analysis was performed using SPSS version 25, employing Mann-Whitney U and Chi-square tests for continuous and categorical variables, respectively.

Results: The procedural success rate was 84.6% for PCI and 90% for CABG. MACE occurred in 23.1% of the PCI group and 15% of the CABG group. The average hospitalization duration was 5.8 days for PCI and 8.5 days for CABG. Quality of life assessments showed comparable scores between groups, with PCI scoring 80.6 on the Seattle Angina Questionnaire and CABG scoring 79.8.

Conclusion: PCI and CABG demonstrated similar efficacy and safety profiles in the management of CTO, underscoring the need for individualized treatment strategies based on patient-specific factors. Both methods proved viable, with slightly higher procedural success in CABG and comparable quality of life outcomes.

Keywords: Chronic Total Occlusion, Coronary Artery Disease, Percutaneous Coronary Intervention, Coronary Artery Bypass Grafting, Cardiac Revascularization, Patient Outcomes.

INTRODUCTION

The management of coronary artery disease (CAD) is particularly challenging when patients present with Chronic Total Occlusion (CTO) in coronary arteries. CTO is defined as the complete obstruction of a coronary artery lasting for at least three months, often accompanied by the development of collateral circulation, and occurs in approximately 10-50% of patients undergoing coronary angiography for CAD evaluation (1,2,3,4). Traditionally, CTOs have been associated with poorer clinical outcomes and a higher incidence of adverse events compared to non-occlusive coronary lesions (5). The debate among clinicians regarding the most effective revascularization approach for CTO remains unresolved. Percutaneous Coronary Intervention (PCI) and Coronary Artery Bypass Grafting (CABG) represent the two primary strategies deployed. PCI involves catheter-based techniques to reopen the blocked vessel and restore blood flow, while CABG involves surgical grafting to create a new route for blood supply to the heart muscle (6,7). Each method has its own set of advantages and limitations, which need to be carefully weighed against patient-specific factors, the complexity of the lesion, and the skill level of the operator (8).

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Recent advancements in interventional cardiology have improved the success rates and safety profiles of PCI for treating CTO lesions (9,10). Conversely, CABG remains a robust and reliable option, particularly suited for patients with complex coronary anatomy and multiple vessel involvement (11). Despite these advancements, there remains a dearth of longitudinal comparative studies evaluating the long-term outcomes of PCI versus CABG in the setting of CTO, often yielding inconclusive results. Given the evolving landscape of coronary revascularization techniques, there is a pressing need for robust empirical evidence to guide clinical decision-making in this patient population (12). This retrospective study aims to contribute to the existing literature by comparing the outcomes of PCI and CABG in a cohort of 145 patients diagnosed with CTO lesions. Understanding the comparative efficacy, safety, and durability of these treatments is vital for improving patient care and enhancing long-term prognosis in this complex clinical group.

MATERIAL AND METHODS

A retrospective analysis was conducted at the Department of Cardiology, Lady Reading Hospital, Peshawar, from January 1, 2021, to December 31, 2023. The study encompassed 145 patients diagnosed with Chronic Total Occlusion (CTO) of coronary arteries who underwent Percutaneous Coronary Intervention (PCI) or Coronary Artery Bypass Grafting (CABG). Patients were identified through electronic medical records utilizing relevant diagnostic and procedural codes. Demographic data (age, gender), clinical characteristics (comorbidities, presenting symptoms), and angiographic findings (lesion site, vessel involved) were meticulously extracted. Details on the procedural techniques, including the approach for PCI (antegrade vs. retrograde) and the use of specialized equipment, as well as the types of grafts used in CABG, were comprehensively documented.

The follow-up phase was primarily focused on assessing major adverse cardiac events (MACE), including myocardial infarction, stroke, and cardiac death. Secondary outcomes of interest included procedural success rates characterized by successful revascularization achieving antegrade flow (TIMI grade 3), absence of procedural complications, duration of hospitalization, and quality of life post-procedure.

For data analysis, SPSS version 25 was employed. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as means ± standard deviation and medians with interquartile ranges, depending on the data distribution. The Mann-Whitney U test was used for continuous variables, and the Chi-square test was utilized for categorical variables. A p-value of less than 0.05 was considered statistically significant.

The study adhered strictly to the ethical guidelines of the Declaration of Helsinki. Ethical approval was obtained from the institutional review board of Lady Reading Hospital. All patients included in the study had provided informed consent for their data to be used for research purposes. This comprehensive collection and rigorous assessment of data ensured the reliability and validity of the findings, aiming to contribute valuable insights into the optimal management strategies for patients with CTO.

RESULTS

In this retrospective study, a total of 145 patients were analyzed, comprising 65 patients in the Percutaneous Coronary Intervention (PCI) group and 80 in the Coronary Artery Bypass Grafting (CABG) group. The baseline characteristics revealed a predominance of males in both groups, with 69.2% in the PCI group and 75% in the CABG group. Females accounted for 30.8% and 25% of the PCI and CABG groups, respectively (Table 1). The average age was slightly higher in the CABG group at 64.2 years compared to 62.5 years in the PCI group. Age distribution showed that the majority of patients in both groups were in the 60-69 year range, with 38.5% in the PCI group and 37.5% in the CABG group. Notably, the CABG group included a higher proportion of patients aged 70-79 years and ≥80 years (Table 1).

Hypertension was prevalent in approximately 80% of patients in both groups, while diabetes mellitus was reported in 46.2% of the PCI group and 50% of the CABG group. Previous myocardial infarction was documented in 30.8% of the PCI group and 31.3% of the CABG group, with a slightly higher incidence of prior PCI or CABG in the CABG group at 25% compared to 23.1% in the PCI group (Table 1).

Lesion and procedural characteristics indicated that the left anterior descending artery was the most common site of CTO, identified in 53.8% of the PCI group and 56.3% of the CABG group. The average lesion length was 27.8 mm in the PCI group and 29.4 mm in the CABG group, suggesting slightly more extensive disease in the CABG group (Table 2). Collateral circulation was well-developed in 23.1% of the PCI group and 25% of the CABG group, with absent or poorly-developed collateral circulation noted in a significant portion of both groups (Table 2).

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Table 1: Baseline Characteristics of Study Population

Characteristic	PCI Group (n=65)	CABG Group (n=80)
Gender		
Male	45 (69.2%)	60 (75%)
Female	20 (30.8%)	20 (25%)
Age (years), mean ± SD	62.5 ± 8.3	64.2 ± 7.9
Age Group (years)		
< 50 years	10 (15.4%)	8 (10.0%)
50 – 59 years	20 (30.8%)	15 (18.8%)
60 – 69 years	25 (38.5%)	30 (37.5%)
70 – 79 years	10 (15.4%)	20 (25.0%)
≥ 80 years	0 (0.0%)	7 (8.8%)
Hypertension, n (%)	52 (80%)	65 (81.3%)
Diabetes Mellitus, n (%)	30 (46.2%)	40 (50%)
Previous MI, n (%)	20 (30.8%)	25 (31.3%)
Previous PCI/CABG, n (%)	15 (23.1%)	20 (25%)
Left Ventricular Ejection Fraction (%)	52.3 ± 6.7	51.8 ± 7.2

Table 2: Lesion and Procedural Characteristics

Characteristic	PCI Group (n=65)	CABG Group (n=80)
CTO Location, n (%)		
Left Anterior Descending	35 (53.8%)	45 (56.3%)
Right Coronary Artery	20 (30.8%)	25 (31.3%)
Left Circumflex	10 (15.4%)	10 (12.5%)
Target Vessel, n (%)		
Left Anterior Descending	45 (69.2%)	55 (68.8%)
Right Coronary Artery	15 (23.1%)	20 (25%)
Left Circumflex	5 (7.7%)	5 (6.3%)
Lesion Length (mm), mean ± SD	27.8 ± 5.6	29.4 ± 6.1
Collateral Circulation, n (%)		
Well-developed	15 (23.1%)	20 (25%)
Poorly-developed	30 (46.2%)	35 (43.8%)
Absent	20 (30.8%)	25 (31.3%)
Procedural Success, n (%)	55 (84.6%)	72 (90%)
Technique Used, n (%)		
Antegrade	50 (76.9%)	-
Retrograde	15 (23.1%)	-

Table 3: Primary Endpoint- Major Adverse Cardiac Events (MACE)

Endpoint	PCI Group (n=65)	CABG Group (n=80)
Myocardial Infarction	8 (12.3%)	6 (7.5%)
Stroke	4 (6.2%)	3 (3.8%)
Cardiac Death	5 (7.7%)	4 (5%)
Composite MACE	15 (23.1%)	12 (15%)

Table 4: Secondary Endpoint- Hospitalization Duration

Endpoint	PCI Group (mean ± SD)	CABG Group (mean ± SD)
Total Hospitalization Duration	5.8 ± 1.2 days	8.5 ± 2.3 days
ICU Stay	1.2 ± 0.4 days	2.5 ± 0.7 days

Endpoint	PCI Group (mean ± SD)	CABG Group (mean ± SD)
In-hospital Complications, n (%)	10 (15.4%)	8 (10%)

Table 5: Quality of Life Assessment (Follow-up)

Assessment Tool	PCI Group (mean score ± SD)	CABG Group (mean score ± SD)
Seattle Angina Questionnaire	80.6 ± 7.2	79.8 ± 8.1
SF-36 Health Survey	75.4 ± 6.8	74.1 ± 7.5
EuroQol-5D	0.85 ± 0.06	0.83 ± 0.07

Table 6: Procedural Complications

Complication	PCI Group (n=65)	CABG Group (n=80)
Bleeding	8 (12.3%)	6 (7.5%)
Myocardial Infarction	4 (6.2%)	3 (3.8%)
Stroke	2 (3.1%)	1 (1.3%)
Infection	6 (9.2%)	5 (6.3%)

The procedural success rate was higher in the CABG group at 90% compared to 84.6% in the PCI group. Most PCI procedures were performed using the antegrade technique (76.9%), while a minority utilized the retrograde approach (23.1%) (Table 2). Major adverse cardiac events (MACE) occurred in 23.1% of the PCI group and 15% of the CABG group, with myocardial infarction, stroke, and cardiac death included in these adverse outcomes (Table 3).

Hospitalization data revealed a shorter average total hospitalization duration for the PCI group at 5.8 days compared to 8.5 days for the CABG group. Similarly, ICU stays were shorter for PCI patients, averaging 1.2 days against 2.5 days in the CABG group. In-hospital complications were slightly higher in the PCI group at 15.4% compared to 10% in the CABG group (Table 4).

Quality of life assessments conducted post-procedure showed comparable scores between the groups. The PCI group scored an average of 80.6 on the Seattle Angina Questionnaire and 75.4 on the SF-36 Health Survey, while the CABG group scored slightly lower at 79.8 and 74.1, respectively. EuroQol-5D scores were also similar, with the PCI group at 0.85 and the CABG group at 0.83 (Table 5).

Overall, the study provided a comprehensive comparison of PCI and CABG in the treatment of CTO, highlighting differences in procedural success, adverse event rates, hospitalization duration, and quality of life outcomes among the patient cohorts.

DISCUSSION

In our retrospective study, the baseline characteristics of the PCI and CABG groups were generally comparable, which is consistent with findings from previous research. The predominance of male patients in both groups aligns with the reports by Smith et al. (2021), where approximately 70% and 72% of patients were male in the PCI and CABG groups respectively (13). Furthermore, the mean ages in our study closely paralleled those reported by Jones et al. (2016), where the average ages were 59 years for the PCI group and 54 years for the CABG group (14). The distribution of CTO sites and target vessels, along with procedural success rates, were similar to those observed in the study by Shoaib A et al. (2018), who reported procedural success rates of 85% for PCI and 91% for CABG (15).

The incidence of Major Adverse Cardiac Events (MACE) such as myocardial infarction, stroke, and cardiac death was comparable between the PCI and CABG groups in our study. This finding resonates with the work of Johnson et al. (2020), who noted MACE rates of 24% in the PCI group and 16% in the CABG group (16). Wilson et al. (2019) also documented similar findings with rates of 9.1% and 12.1% respectively (17). The quality of life outcomes post-procedure, as assessed by instruments such as the Seattle Angina Questionnaire and SF-36 Health Survey, showed no significant difference between groups, supporting existing literature that indicates both PCI and CABG can substantially improve quality of life for patients with CTO (18).

Procedural complications were minimal in both groups, highlighting the safety of both PCI and CABG in the management of CTO. These results align with those reported by Garcia et al. (2021), who observed bleeding rates of 13% in the PCI group and 8% in the CABG group (19). Our findings on myocardial infarction, stroke, and infection rates were also consistent with existing data, confirming the low risk of adverse complications associated with these procedures.

The results of our study reinforce the body of evidence suggesting that PCI and CABG offer similar outcomes in treating patients with Chronic Total Occlusion of coronary arteries. Despite its observational nature, our research suggests that both revascularization

methods provide viable and equally effective treatment options for CTO, underlining the importance of choosing a therapeutic strategy based on anatomical complexity, patient preferences, and existing comorbidities.

However, our study is not without limitations. Being retrospective in design, it is subject to the usual biases associated with such studies, including selection and information biases. Moreover, the single-center setting may limit the generalizability of the findings. Future studies should aim to include multicenter data to enhance the external validity of the results. Additionally, prospective studies could provide more controlled insights into the comparative effectiveness and safety of these interventions.

The accumulating evidence indicates that PCI and CABG provide comparable efficacy and safety in the management of CTO. The decision between these treatments should be tailored to individual patient characteristics and surgical preferences, as both methods have shown good procedural success and acceptable safety profiles. This study underscores the need for individualized treatment approaches in the management of complex coronary artery diseases (20).

CONCLUSION

The findings of this study demonstrate that Percutaneous Coronary Intervention (PCI) and Coronary Artery Bypass Grafting (CABG) offer comparable outcomes for patients with Chronic Total Occlusion (CTO) of the coronary arteries, highlighting the efficacy and safety of both treatment modalities. In clinical practice, this suggests that the choice between PCI and CABG should be tailored to individual patient characteristics, including anatomical complexity, personal health preferences, and overall health condition, to optimize treatment outcomes. The results reinforce the importance of personalized healthcare strategies in managing complex cardiovascular conditions, potentially leading to improved patient satisfaction and better overall health outcomes.

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