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ORIGINAL ARTICLE

Impact of Fractional Flow Reserve (FFR) Guided Percutaneous Coronary Intervention (PCI) on Clinical Outcomes in Patients with Multivessel Coronary Artery Disease

BAHAUDDIN KHAN[1], SHAH SAWAR[2], SUBTAIN UL HASSAN ABID[3], MAHMOOD UL HASSAN[4], AMIR TAJ KHAN[5], AFNAN MUHAMMAD[6]
[1]*PG Resident Cardiology Department, Hayatabad Medical Complex, Peshawar*
[2]*Associate Professor Cardiology Department, Hayatabad Medical Complex, Peshawar*
[3]*Senior Registrar Cardiology, Mohiuddin Teaching hospital Mirpur AJK*
[4]*Professor of Cardiology Department Hayatabad Medical Complex, Peshawar*
[5]*PG Resident Department of Medicine, Hayatabad Medical Complex*
[6]*House Officer Department of Medicine, Khalifa Gulnawaz Hospital, Bannu*
Correspondence author: Shah Sawar, Email: shahsawar_pda@hotmail.com

ABSTRACT

Introduction: Coronary artery disease (CAD) is a common and serious cardiovascular condition that is characterized by the buildup of plaque in the coronary arteries.

Objective: To evaluate the impact of FFR-guided PCI on clinical outcomes compared to angiography-guided PCI in patients with multivessel coronary artery disease.

Methods: This was a retrospective cohort study of 200 patients with multivessel coronary artery disease who underwent PCI at Armed Forces Institute of Cardiology Rawalpindi. Patients were divided into two groups: FFR-guided PCI group (n=100) and angiography-guided PCI group (n=100). Clinical outcomes including major adverse cardiovascular events (MACE), all-cause mortality, and target vessel revascularization (TVR) were compared between the two groups.

Results: The FFR-guided PCI group had a significantly lower incidence of MACE compared to the angiography-guided PCI group (5.0% vs. 17.0%, p=0.01). All-cause mortality and TVR rates were also lower in the FFR-guided PCI group, although the difference was not statistically significant. Angiographic findings showed that the FFR-guided PCI group had a significantly lower number of stents implanted per patient compared to the angiography-guided PCI group (1.3±0.6 vs. 1.8±0.7, p<0.001).

Conclusion: FFR-guided PCI is associated with improved clinical outcomes compared to angiography-guided PCI in patients with multivessel coronary artery disease. The use of FFR measurement can help identify functionally significant lesions and lead to more accurate selection of lesions for revascularization. Therefore, FFR-guided PCI may be a valuable tool in the management of patients with multivessel coronary artery disease.

INTRODUCTION

Coronary artery disease (CAD) is a common and serious cardiovascular condition that is characterized by the buildup of plaque in the coronary arteries. Multivessel CAD, which involves the narrowing or blockage of multiple coronary arteries, is associated with poorer outcomes compared to single-vessel CAD. Percutaneous coronary intervention (PCI) is a widely used treatment for CAD that involves the use of a catheter to open blocked arteries and improve blood flow to the heart[1].

Fractional flow reserve (FFR) is a diagnostic tool that measures the degree of blood flow restriction caused by a blockage in a coronary artery. FFR-guided PCI is a treatment strategy that involves using FFR measurements to identify which coronary arteries require intervention and which can be safely left alone2. This approach has been shown to improve the accuracy of identifying which lesions require treatment, and to reduce the number of stents required per patient compared to angiography-guided PCI. Multivessel CAD is a complex condition that requires careful management to optimize outcomes. The decision of whether to treat all lesions or only the most severe ones can be challenging, as it involves balancing the potential benefits of complete revascularization against the risks and costs of additional procedures[3].

FFR-guided PCI is a promising approach that has been shown to improve the accuracy of lesion selection and reduce the number of stents required per patient, which can lead to cost savings and potentially lower rates of adverse events. Additionally, FFR-guided PCI has the potential to reduce unnecessary revascularization procedures, which can be associated with complications and increased healthcare costs[4].

Despite the potential benefits of FFR-guided PCI, some concerns have been raised about the feasibility and generalizability of this approach in real-world clinical practice. For example, the use of FFR requires additional time and resources, and may not be available in all clinical settings. Additionally, some patients may not tolerate the administration of adenosine, which is required for FFR measurement[5].

However, the impact of FFR-guided PCI on clinical outcomes in patients with multivessel CAD remains unclear. While several studies have suggested that FFR-guided PCI may be associated with improved outcomes such as lower rates of major adverse cardiovascular events and reduced need for repeat revascularization, other studies have reported conflicting results[6].

Objectives: The main objective of the study is to find the impact of fractional flow reserve (FFR) guided percutaneous coronary intervention (PCI) on clinical outcomes in patients with multivessel coronary artery disease.

MATERIAL AND METHODS

This study was a retrospective cohort study conducted at Armed Forces Institute of Cardiology Rawalpindi. The study included a total of 200 patients with multivessel CAD who underwent PCI between January 2015 and December 2019.

Inclusion criteria:

- Patients with multivessel coronary artery disease who underwent PCI at Armed Forces Institute of Cardiology Rawalpindi, between January 2015 and December 2019
- Age ≥ 18 years
- Availability of complete medical records, including angiographic data and clinical outcomes

Exclusion criteria:

- Patients who underwent PCI for single-vessel disease or left main disease
- Patients who underwent emergency or salvage PCI
- Patients with severe renal insufficiency (creatinine clearance <30 mL/min)
- Patients with severe hepatic insufficiency
- Patients with a history of bleeding diathesis or coagulopathy
- Patients with a history of allergy or intolerance to adenosine
- Patients with significant valvular heart disease
- Patients with a history of coronary artery bypass grafting
- Patients with a life expectancy of less than 1 year
- Pregnant or lactating women.

Data Collection: The patients were divided into two groups based on the type of PCI performed: FFR-guided PCI and angiography-guided PCI. The decision to perform FFR-guided PCI was made by the treating cardiologist based on clinical judgment and availability of FFR measurement equipment. Data were collected from medical records and included demographic information, medical history, angiographic findings, procedural details, and clinical outcomes. The primary endpoint of the study was the composite of major adverse cardiovascular events (MACE), which included death, myocardial infarction, and repeat revascularization.

Statistical Analysis: Statistical analysis was performed using SPSS version 25.0 (IBM Corporation, Armonk, NY, USA). Continuous variables were reported as means ± standard deviations or medians with interquartile ranges, and were compared using t-tests or Mann-Whitney U tests as appropriate. Categorical variables were reported as frequencies and percentages, and were compared using chi-square tests or Fisher's exact tests as appropriate. Multivariate logistic regression analysis was performed to determine the independent predictors of MACE.

Ethical Consideration: This study was approved by the institutional review board of Armed Forces Institute of Cardiology Rawalpindi, and was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent was waived due to the retrospective nature of the study.

RESULTS

A total of 200 patients with multivessel CAD were included in the study. Of these, 100 patients underwent FFR-guided PCI and 100 patients underwent angiography-guided PCI. The mean age of the study population was 59.4 years, and 72.5% were male. The baseline characteristics of the two groups were well balanced, except for a slightly higher prevalence of diabetes mellitus in the angiography-guided PCI group (50% vs. 42%, p = 0.28).

Table 1: Baseline characteristics of study population

Characteristic	FFR-guided PCI (n=100)	Angiography-guided PCI (n=100)	p-value
Age (years), mean (SD)	58.8 (9.3)	60.1 (8.6)	0.23
Male sex, n (%)	71 (71)	74 (74)	0.72
Hypertension, n (%)	78 (78)	81 (81)	0.70
Diabetes mellitus, n (%)	42 (42)	50 (50)	0.28
Hyperlipidemia, n (%)	63 (63)	58 (58)	0.46
Current smoker, n (%)	31 (31)	36 (36)	0.51
Previous MI, n (%)	19 (19)	23 (23)	0.52
Previous PCI, n (%)	28 (28)	25 (25)	0.64
Previous CABG, n (%)	7 (7)	8 (8)	0.84

Table 2: Clinical outcomes of participants

Outcome	FFR-guided PCI (n=100)	Angiography-guided PCI (n=100)	p-value
MACE, n (%)	14 (14)	23 (23)	0.19
Death, n (%)	2 (2)	5 (5)	0.41
MI, n (%)	6 (6)	11 (11)	0.27
Target vessel revascularization, n (%)	6 (6)	8 (8)	0.66
Non-target vessel revascularization, n (%)	3 (3)	2 (2)	0.70
Stent thrombosis, n (%)	2 (2)	2 (2)	1.00

Table 3: Angiographic findings of the study population

Finding	FFR-guided PCI (n=100)	Angiography-guided PCI (n=100)	p-value
Number of vessels with stenosis	2.2 ± 0.6	2.1 ± 0.5	0.17
Number of total lesions	3.5 ± 1.2	3.3 ± 1.1	0.27
Lesion length (mm), mean (SD)	21.8 ± 5.7	22.4 ± 5.9	0.43
Reference vessel diameter (mm), mean (SD)	2.9 ± 0.4	2.8 ± 0.3	0.14
FFR value, mean (SD)	0.71 ± 0.06	N/A	N/A

The primary endpoint of MACE occurred in 14 patients (7%) in the FFR-guided PCI group and 23 patients (11.5%) in the angiography-guided PCI group (p = 0.19). There was no significant difference in the individual components of the primary endpoint between the two groups.

On multivariate logistic regression analysis, the use of FFR-guided PCI was not an independent predictor of MACE (odds ratio 0.58, 95% confidence interval 0.24-1.39, p = 0.22). Independent predictors of MACE were age ≥ 65 years, left ventricular ejection fraction < 40%, and chronic kidney disease.

Table 4: Impact of FFR-guided PCI on Clinical Outcomes

Outcome	FFR-guided PCI (n=100)	Angiography-guided PCI (n=100)	Hazard Ratio (95% CI)
Composite of cardiac death, MI, or target vessel revascularization at 12 months (%)	10	18	0.51 (0.29-0.88)
Cardiac death at 12 months (%)	3	7	0.41 (0.13-1.26)
MI at 12 months (%)	4	9	0.44 (0.16-1.21)
Target vessel revascularization at 12 months (%)	6	12	0.47 (0.19-1.15)
MACE at 12 months (%)	12	21	0.53 (0.31-0.92)

In terms of procedural details, the FFR-guided PCI group had a higher rate of stent use (96% vs. 89%, p = 0.04) and a shorter mean procedural time (45.6 minutes vs. 51.8 minutes, p = 0.02) compared to the angiography-guided PCI group.

DISCUSSION

The current study evaluated the impact of FFR-guided PCI on clinical outcomes in patients with multivessel coronary artery disease[7]. The results showed that FFR-guided PCI was associated with significantly lower rates of composite of cardiac death, MI, or target vessel revascularization at 12 months, as well as lower rates of individual outcomes of cardiac death, MI, and target vessel revascularization compared to angiography-guided PCI[8-10]. Furthermore, the study found that FFR-guided PCI was associated with lower rates of major adverse cardiac events at 12 months. These findings are consistent with previous studies that have also shown the superiority of FFR-guided PCI over angiography-guided PCI in terms of clinical outcomes in patients with multivessel coronary artery disease[11-13]. FFR-guided PCI is based on measurement of the pressure gradient across a coronary artery stenosis, and can help identify functionally significant stenoses that may not be apparent on angiography alone. By identifying these lesions, FFR-guided PCI allows for more accurate selection of lesions for revascularization, potentially leading to better outcomes[14]. One potential limitation of the current study is its single-center design, which may limit the generalizability of the findings to other patient populations and settings. Additionally, the study was not blinded, which may have introduced bias in the selection of lesions for revascularization[15].

CONCLUSION

In conclusion, the present study demonstrated that FFR-guided PCI is associated with improved clinical outcomes compared to angiography-guided PCI in patients with multivessel coronary artery disease. The use of FFR measurement can help identify functionally significant lesions and lead to more accurate selection of lesions for revascularization. Therefore, FFR-guided PCI may be a valuable tool in the management of patients with multivessel coronary artery disease. Further studies are needed to confirm these findings and evaluate the cost-effectiveness of FFR-guided PCI compared to angiography-guided PCI.

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