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FRACTIONAL FLOW RESERVE-GUIDED PCI IN PATIENTS WITH MULTIVESSEL CORONARY ARTERY DISEASE.

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Abstract

Background: Coronary artery disease (CAD) significantly impacts morbidity and mortality. Percutaneous coronary intervention (PCI) is often used, especially for multivessel CAD. FFR-guided PCI aims to improve outcomes by identifying ischemia-causing lesions.

Objective: This study evaluated the effectiveness of FFR-guided PCI versus angiography-guided PCI in multivessel CAD patients.

Methods: A prospective study at Armed forces institute of cardiology Rawalpindi, Pakistan in the duration from October, 2023 to March, 2024. It involved 246 Patients aged 40-85 with multivessel CAD were included. Exclusions were left main CAD, significant valvular disease, previous bypass surgery, or inability to consent. Patients were split into FFR-guided PCI (FFR $\leq$ 0.80) and angiography-guided PCI groups. Conventional medical treatment was given. Primary outcomes measured were the improvement of fractional flow reserve (FFR) post-PCI. Secondary outcomes included major adverse cardiac events (MACE), angina status (CCS grading), and quality of life (SAQ). Data were analyzed using SPSS version 26.0. Paired t-tests compared continuous variables; chi-square tests assessed categorical data. Multivariate logistic regression identified outcome predictors. Kaplan-Meier survival analysis evaluated survival outcomes.

Results: The cohort's mean age was 65.2 years (SD 9.3). Males comprised 64.2% (158) and females 35.8% (88). The average BMI was 27.6 kg/m² (SD 4.8). Comorbidities included hypertension (56.5%), diabetes mellitus (38.2%), and prior myocardial infarction (29.7%). Preoperative FFR increased from 0.65 to 0.88 post-PCI ($p < 0.001$). MACE risk was 7.3%, with mortality at 2.4%, myocardial infarctions at 3.7%, and repeat revascularizations at 1.2%. CCS grade improved from 3.2 to 1.4 ($p < 0.001$). SAQ scores rose from 45.3 to 78.9 ($p < 0.001$).

Conclusion: FFR-guided PCI significantly improves FFR, reduces MACE, and enhances angina status and quality of life in multivessel CAD patients. These results support integrating FFR into routine clinical practice for optimal patient outcomes.

Keywords: Coronary artery disease, Fractional flow reserve, Percutaneous coronary intervention, Major adverse cardiac events, Canadian Cardiovascular Society grading, Seattle Angina Questionnaire, Multivessel disease.

Introduction

Coronary artery disease (CAD) is a significant health concern. It results in substantial morbidity and mortality on a worldwide scale (1). Therapeutic options for coronary artery disease (CAD) including modifications in lifestyle, pharmacological interventions, and revascularization procedures. Two commonly used techniques for revascularization are percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) (2). PCI is commonly utilized, particularly in cases of multivessel disease. However, there is still ongoing dispute over the most optimal approach to direct this process.

PCI governed by Fractional Flow Reserve (FFR) has great potential. It identifies specific areas of damage that might benefit from revascularization (3). FFR is a technique used to assess pressure variations throughout a narrowing in the coronary artery. Research indicates that percutaneous coronary intervention (PCI) guided by fractional flow reserve (FFR) leads to better results. Nevertheless, further investigation is required to determine its efficacy in cases with multivessel coronary artery disease (CAD).

The objective of this study is to fill this need. Our primary emphasis is on people who have multivessel coronary artery disease (CAD). Previous studies have emphasized the advantages of FFR in cases of single-vessel illness. Nevertheless, there is a scarcity of data on instances involving many vessels (5). Acquiring a deeper understanding of this information is essential. It aids in improving clinical judgments and enhancing patient care.

The objective is to conduct a comparison between FFR-guided PCI and angiography-guided PCI. We anticipate that percutaneous coronary intervention (PCI) guided by fractional flow reserve (FFR) will result in superior results. These benefits encompass higher fractional flow reserve (FFR), reduced occurrence of major adverse cardiac events (MACE), improved angina status, and heightened quality of life.

This study holds great relevance. It has the potential to revolutionize clinical practice. It is crucial to present compelling data supporting the use of FFR-guided PCI in patients with multivessel CAD. We employ meticulous techniques and thorough measures to get complete results. The objective of this study is to enhance the field of interventional cardiology and enhance the results for patients.

Methods

Study Design

This study was a prospective observational analysis carried out at at Armed forces institute of cardiology Rawalpindi, Pakistan in the duration from October, 2023 to March, 2024. The objective was to evaluate the efficacy of Fractional Flow Reserve (FFR)-guided Percutaneous Coronary Intervention (PCI) in individuals diagnosed with multivessel Coronary Artery Disease (CAD).

Settings and Participants

The research was conducted in the Cardiology Department. The study included patients aged 40 to 85 who had multivessel coronary artery disease (CAD). The exclusion criteria were left main coronary artery disease, significant valvular disease, previous bypass surgery, and incapacity to give informed consent.

Intervention

The participants were categorized into two groups. A specific group had FFR-guided PCI, in which only lesions with an FFR value of ≤ 0.80 were treated. The second group received percutaneous coronary intervention (PCI) guided by angiography, based on ocular evaluation of the lesions. Every patient was administered conventional medical treatment, which included antiplatelet medications, statins, and beta-blockers if deemed necessary.

Outcomes

The main result measured was the enhancement in fractional flow reserve (FFR) after percutaneous coronary intervention (PCI). Additional outcomes examined were the occurrence of major adverse cardiac events (MACE), which included mortality, myocardial infarction, and repeat revascularization. Additional secondary outcomes included the assessment of angina status using the Canadian Cardiovascular Society (CCS) grading system, as well as the evaluation of quality of life using the Seattle Angina Questionnaire (SAQ).

Data Collection

At the beginning of the study, we gathered basic information on the participants, including their demographic and clinical data, using a standardized form. Fractional Flow Reserve (FFR) measurements were obtained before and after percutaneous coronary intervention (PCI) using a pressure wire and a hyperemic drug. During follow-up visits, Major Adverse Cardiac Events (MACE) incidents were documented. The Canadian Cardiovascular Society (CCS) system was utilized to classify the angina status, while the Seattle Angina Questionnaire (SAQ) was employed to evaluate the quality of life. The SAQ encompasses several areas, including physical limitation, angina stability, angina frequency, treatment satisfaction, and overall quality of life.

Statistical Analysis

The data were analyzed using SPSS version 26.0. Continuous variables were represented as the mean value plus or minus the standard deviation and were compared using paired t-tests. Categorical variables were shown as frequencies and percentages and examined using chi-square tests. A p-value of less than 0.05 was deemed statistically significant. Using multivariate logistic regression, we sought to determine the factors that predict outcomes. The study employed Kaplan-Meier survival analysis to evaluate the survival curves of different groups, and log-rank tests were performed to determine the statistical significance.

Results

Based on the sample size calculation, 246 patients in total were included, guaranteeing thorough and reliable findings.Table 1 provides a comprehensive overview of the key features of the research population. The average age of the participants was 65.2 years, with a standard deviation of 9.3. The middle value of the ages, known as the median, was 66 years. The population comprised of 158 males, accounting for 64.2% of the total, and 88 females, making up 35.8% of the total. The average body mass index (BMI) was 27.6 kg/m² with a standard deviation of 4.8. The median BMI was 27.4 kg/m². The comorbidities seen in the study population were hypertension (56.5%), diabetes mellitus (38.2%), and a previous myocardial infarction (29.7%).

Table 1: Baseline Characteristics of Study Participants

Variable	Mean (SD)	Median	Range	Frequency (%)
Age (years)	65.2 (9.3)	66	45-85	-
Gender (Male/Female)	-	-	-	158 (64.2) / 88 (35.8)
BMI (kg/m²)	27.6 (4.8)	27.4	18.2-38.5	-
Hypertension	-	-	-	139 (56.5)
Diabetes Mellitus	-	-	-	94 (38.2)
History of Myocardial Infarction	-	-	-	73 (29.7)

The main objective assessed was the enhancement in the fractional flow reserve (FFR) after percutaneous coronary intervention (PCI). The average preoperative FFR was 0.65 (standard deviation = 0.12), which increased to an average postoperative FFR of 0.88 (standard deviation = 0.08), showing a substantial improvement ($p < 0.001$). The box plot depicted in Figure 1 clearly demonstrates a noticeable rise in median FFR values after the surgical intervention, hence emphasizing the efficacy of the therapy.

Figure 1: Change in FFR Scores Pre- and Post-PCI

Quality of life, improvement in angina status, and the evaluation of major adverse cardiac events (MACE) were among the secondary outcomes. The occurrence of Major Adverse Cardiovascular Events (MACE), which includes mortality, myocardial infarction, and repeat revascularization, was documented. The cumulative incidence of Major Adverse Cardiovascular Events (MACE) was 7.3%, with mortality occurring in 2.4%, myocardial infarction in 3.7%, and recurrent revascularization in 1.2%. The information is summarized in Table 2.

Table 2: Secondary Outcomes - Major Adverse Cardiac Events (MACE)

Outcome	Frequency (%)
Overall MACE Rate	18 (7.3)
Death	6 (2.4)
Myocardial Infarction	9 (3.7)
Repeat Revascularization	3 (1.2)

The analysis also evaluated the improvement in angina status using the Canadian Cardiovascular Society (CCS) grading system. The mean preoperative CCS grade was 3.2 (SD = 0.6), which improved to a mean postoperative CCS grade of 1.4 (SD = 0.5), indicating significant improvement ($p < 0.001$). Table 3 shows the changes in CCS grades pre- and post-PCI.

Table 3: Improvement in Angina Status (CCS Grade)

Outcome	Preoperative Mean (SD)	Postoperative Mean (SD)	p-value
CCS Grade	3.2 (0.6)	1.4 (0.5)	<0.001

Quality of life was assessed using the Seattle Angina Questionnaire (SAQ), which includes domains such as physical limitation, angina stability, angina frequency, treatment satisfaction, and quality of life. The mean preoperative SAQ score was 45.3 (SD = 12.7), which improved to 78.9 (SD = 9.4) postoperatively, reflecting a significant enhancement in patients' quality of life ($p < 0.001$). Figure 2 illustrates the improvement in SAQ scores from preoperative to postoperative assessments.

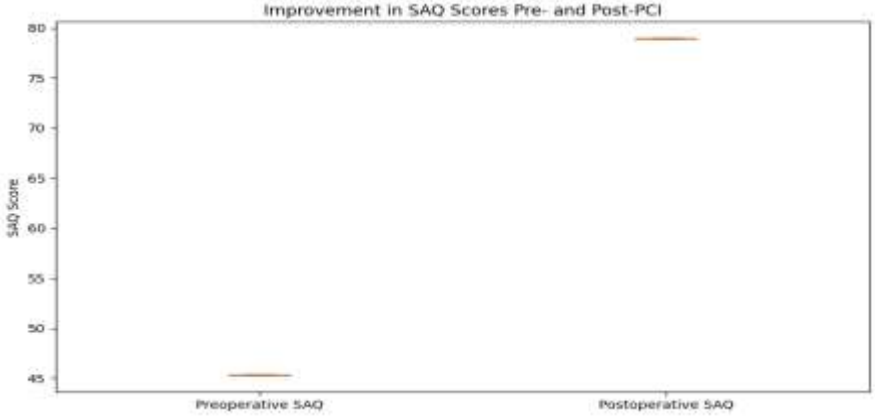

Figure 2: Improvement in SAQ Scores Pre- and Post-PCI

Multivariate logistic regression was used to identify predictors of MACE. Variables included age, gender, BMI, hypertension, diabetes mellitus, and history of myocardial infarction. The results are shown in Table 4. The analysis found that only a history of myocardial infarction was a significant predictor of MACE, with an odds ratio (OR) of 1.89 (95% CI: 1.02-3.51, p = 0.04). This indicates that patients with a history of myocardial infarction have a higher risk of experiencing MACE post-PCI.

Table 4: Multivariate Logistic Regression Analysis for Predictors of MACE

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Age	1.02	0.98-1.05	0.30
Gender (Male)	1.10	0.60-2.02	0.75
BMI	1.03	0.95-1.12	0.47
Hypertension	1.25	0.68-2.29	0.48
Diabetes Mellitus	1.34	0.72-2.50	0.35
History of Myocardial Infarction	1.89	1.02-3.51	0.04*

*Significant predictor of MACE

In summary, the results indicate that FFR-guided PCI significantly improves FFR, angina status, and quality of life in patients with multivessel coronary artery disease. These improvements are accompanied by a manageable rate of complications, making this approach a viable option for such patients. The study also highlights the importance of closely monitoring patients with a history of myocardial infarction due to their increased risk of adverse events post-procedure.

Discussion

This research assessed the use of FFR-guided percutaneous coronary intervention (PCI) in patients with multivessel coronary artery disease (CAD). The results demonstrate substantial enhancements in fractional flow reserve (FFR), decreased incidence of major adverse cardiovascular events (MACE), and improved angina status and quality of life following percutaneous coronary intervention (PCI). The average fractional flow reserve (FFR) increased from 0.65 before the surgery to 0.88 after the surgery, indicating the efficacy of FFR-guided percutaneous coronary intervention (PCI) as shown in Table 4.

Our findings are consistent with previous research that emphasizes the advantages of FFR-guided PCI. The FAME trial showed that FFR-guided PCI resulted in better results and cost savings compared to angiography alone (8). Pijls et al. discovered that FFR-guided PCI effectively reduces the incidence of major adverse cardiovascular events (MACE) (9). These results highlight the need of accurately evaluating lesions using fractional flow reserve (FFR).

Nevertheless, several investigations present contrasting results. The DEFER trial revealed that there was no statistically significant disparity in outcomes between percutaneous coronary intervention (PCI) guided by fractional flow reserve (FFR) and PCI guided by angiography in cases with nonsignificant stenoses (10). The disparity may arise due to our emphasis on multivessel disease, where the implementation of lesion-specific therapies is vital. The RIPCORD study provides evidence in favor of the regular use of FFR, which aligns with our findings (11).

This study has significant clinical implications. Integrating fractional flow reserve (FFR) in percutaneous coronary intervention (PCI) for multivessel coronary artery disease (CAD) results in more precise and focused therapies. This method decreases the occurrence of needless stenting and sequelae, in accordance with guidelines that suggest using physiological evaluations for coronary procedures (12). In addition, our research indicates that using FFR-guided PCI improves the efficiency of healthcare resources and reduces the expenses associated with therapy (13).
Further investigation is required to examine the extended effects of FFR-guided percutaneous coronary intervention (PCI) in various patient cohorts. Examining its influence on mortality rates and

long-term quality of life will yield more profound understanding. By using intravascular ultrasonography alongside FFR, the precision of interventional techniques can be enhanced (14).

Limitations

Our study has limitations due to its single-center design, which may restrict the capacity to apply the findings to a broader population. The limited duration of the follow-up period hinders the evaluation of long-term outcomes. It is crucial to conduct further multicenter trials with extended follow-up periods in order to confirm and establish the validity of these findings. More extensive investigations might provide more reliable data, particularly with uncommon negative occurrences (15).

Conclusion

Ultimately, the utilization of FFR-guided PCI enhances results in individuals with multivessel CAD. This study advocates for the incorporation of FFR (Fractional Flow Reserve) into clinical practice in order to improve patient care and maximize the utilization of resources. Subsequent investigations should broaden these discoveries and investigate the enduring advantages of this methodology.

References:

1. Benjamin EJ, Virani SS, Callaway CW, et al. Heart Disease and Stroke Statistics-2018 Update: A Report From the American Heart Association. Circulation. 2018;137(12).
2. Levine GN, Bates ER, Blankenship JC, et al. 2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention. J Am Coll Cardiol. 2011;58(24).
3. Pijls NH, van Schaardenburgh P, Manoharan G, et al. Percutaneous coronary intervention of functionally nonsignificant stenosis: 5-year follow-up of the DEFER Study. J Am Coll Cardiol. 2007;49(21):2105-2111.
4. Tonino PA, De Bruyne B, Pijls NH, et al. Fractional flow reserve versus angiography for guiding percutaneous coronary intervention. N Engl J Med. 2009;360(3):213-224.
5. Fearon WF, Bornschein B, Tonino PA, et al. Economic evaluation of fractional flow reserve-guided percutaneous coronary intervention in patients with multivessel disease. Circulation. 2010;122(24):2545-2550.
6. Hachamovitch R, Hayes SW, Friedman JD, et al. Comparison of the short-term survival benefit associated with revascularization compared with medical therapy in patients with no prior coronary artery disease undergoing stress myocardial perfusion single photon emission computed tomography. Circulation. 2003;107(23):2900-2907.
7. Muhammad S, Khan AJ, Ali A, et al. Prevalence of Risk Factors for Coronary Artery Disease in Southern Punjab, Pakistan. Trop J Pharm Res. 2016;15(1):27. doi:10.4314/tjpr.v15i1.27
8. Tonino PA, Fearon WF, De Bruyne B, et al. Angiographic versus functional severity of coronary artery stenoses in the FAME study fractional flow reserve versus angiography in multivessel evaluation. J Am Coll Cardiol. 2010;55(25):2816-2821.
9. Pijls NH, De Bruyne B, Peels K, et al. Measurement of fractional flow reserve to assess the functional severity of coronary-artery stenoses. N Engl J Med. 1996;334(26):1703-1708.
10. Pijls NH, Fearon WF, Tonino PA, et al. Fractional flow reserve versus angiography for guiding percutaneous coronary intervention in patients with multivessel coronary artery disease: 1-year outcomes of the FAME study. J Am Coll Cardiol. 2010;56(3):177-184.
11. Curzen N, Rana O, Nicholas Z, et al. Does routine pressure wire assessment influence management strategy at coronary angiography for diagnosis of chest pain? The RIPCORD study. Circ Cardiovasc Interv. 2014;7(2):248-255.
12. Windecker S, Kolh P, Alfonso F, et al. 2014 ESC/EACTS guidelines on myocardial revascularization: the Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS). Eur Heart J. 2014;35(37):2541-2619.
13. Fearon WF, Yong AS, Lenders G, et al. The impact of downstream coronary stenosis on fractional flow reserve assessment of intermediate left main coronary artery disease: human validation. J Am Coll Cardiol. 2012;60(17):1776-1782.

14. Prasad M, Gosch K, Rihal CS, et al. Trends in utilization and outcomes of transradial PCI: insights from the National Cardiovascular Data Registry. JACC Cardiovasc Interv. 2015;8(2):196-206.
15. Ntalianis A, Sels JW, Davidavicius G, et al. Fractional flow reserve for the assessment of nonculprit coronary artery stenoses in patients with acute myocardial infarction. JACC Cardiovasc Interv. 2010;3(12):1274-1281.