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QUANTITATIVE PET/CT FOR MYOCARDIAL VIABILITY ASSESSMENT AFTER COMPLEX PCI: EXPLORING THE ROLE OF MICROBIAL INFECTIONS AND INFLAMMATORY BIOMARKERS

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ABSTRACT

Background: To assess myocardial viability using quantitative PET/CT in patients following complex PCI and explore the role of microbial infections and inflammatory biomarkers in predicting myocardial recovery.

Methods: This prospective study included 71 patients who underwent complex PCI at Ayub Teaching Hospital, Abbottabad, between January 2023 and January 2024. PET/CT using 18F-FDG was performed post-PCI to evaluate myocardial viability. Blood samples were collected to analyze inflammatory biomarkers including CRP and IL-6. Microbial infection status was also assessed. Follow-up echocardiography was used to evaluate myocardial recovery.

Results: The majority of patients demonstrated viable myocardium on PET/CT imaging, with 60% of the cohort showing functional myocardial improvement on follow-up. Inflammatory biomarkers, including CRP and IL-6, were moderately elevated in several patients; however, statistical analysis revealed no significant association between these markers and myocardial recovery ($p > 0.05$). Infection was identified in nearly one-third of the patients. Among those with positive findings, Chlamydia pneumoniae was the most frequently detected organism (n = 15), followed by Helicobacter pylori (n = 11) and Cytomegalovirus (n = 4). Despite the presence of these pathogens, no statistically significant correlation was found between infection status or specific microbial species and myocardial recovery outcomes. The majority of patients (n = 41) had no detectable infection. These findings suggest that neither systemic inflammation nor underlying chronic infections had a measurable impact on post-PCI myocardial functional improvement in this study population.

Conclusion: Quantitative PET/CT proved to be a reliable imaging tool for assessing myocardial viability following complex PCI. Although inflammatory markers and microbial infections were

prevalent among patients, their presence did not significantly influence myocardial recovery. This underscores the importance of direct metabolic myocardial assessment through PET/CT over reliance on systemic biomarkers or infection status when evaluating viability and guiding post-revascularization care.

Keywords: Myocardial viability, PET/CT, PCI, CRP, IL-6, microbial infection, inflammation, cardiac recovery

INTRODUCTION

Coronary artery disease remains a leading cause of morbidity and mortality worldwide. For patients with chronic ischemic cardiomyopathy, timely revascularization through percutaneous coronary intervention (PCI) can restore myocardial function provided that the affected myocardium remains viable. Identifying such viable tissue is critical, particularly after complex PCI, where procedural risks and resource allocation are higher [1-3].

Among the available diagnostic tools, positron emission tomography-computed tomography (PET/CT) using 18F-fluorodeoxyglucose (FDG) offers superior accuracy in detecting metabolically active yet dysfunctional myocardial tissue, commonly referred to as hibernating myocardium. This modality allows for perfusion-metabolism mismatch analysis, aiding in clinical decisions regarding revascularization [4-6].

Despite advances in imaging, clinical outcomes are often influenced by systemic factors. Chronic inflammation, reflected by elevated levels of biomarkers such as C-reactive protein (CRP) and interleukin-6 (IL-6), has been associated with adverse cardiovascular events. Additionally, low-grade or subclinical microbial infections, particularly those involving Chlamydia pneumoniae and other pathogens, have been implicated in the progression of atherosclerosis and poor post-intervention outcomes [7-9].

However, the direct influence of these inflammatory and infectious markers on myocardial viability and recovery after PCI remains unclear. Most studies have focused on long-term cardiovascular risk rather than short-term functional improvement. This study aims to fill that gap by examining the relationship between PET/CT-derived myocardial viability, systemic inflammation, and infection status in a Pakistani population undergoing complex PCI. Through this work, we hope to clarify whether systemic markers can predict or confound myocardial recovery in the short term and guide more precise post-PCI care strategies.

METHODOLOGY

This prospective observational study was carried out at the Department of Cardiology, Ayub Teaching Hospital, Abbottabad, over a period of one year, from January 2023 to January 2024. The primary objective was to evaluate the role of quantitative PET/CT imaging in assessing myocardial viability following complex percutaneous coronary intervention (PCI), with a secondary aim to explore the association of microbial infections and inflammatory biomarkers with myocardial recovery.

A total of 71 patients who underwent complex PCI procedures were enrolled using a non-probability consecutive sampling technique. Inclusion criteria comprised adult patients aged 18 years and above with ischemic heart disease, reduced left ventricular ejection fraction (LVEF < 45%), and referred for viability assessment using PET/CT post-PCI. Patients with hemodynamic instability, prior cardiac surgery, or those who declined consent were excluded from the study.

The study was approved by the institutional ethical review board of Ayub Teaching Hospital. Written informed consent was obtained from all participants prior to enrollment, ensuring confidentiality and the right to withdraw at any point without consequence.

After PCI, patients underwent quantitative PET/CT imaging using 18F-FDG to assess myocardial glucose uptake and determine viability status. Standardized uptake values (SUVs) and perfusion-metabolism mismatches were analyzed to quantify viable myocardium. At the same time, patients were assessed for subclinical infections using relevant microbiological assays (including blood

cultures and serological testing for pathogens like Chlamydia pneumoniae). Blood samples were also taken to evaluate levels of key inflammatory biomarkers, including C-reactive protein (CRP), interleukin-6 (IL-6), and procalcitonin.

Demographic details, clinical history, and procedural data were recorded on a structured proforma. Follow-up echocardiography was performed at three months to evaluate myocardial functional recovery, defined as ≥5% absolute improvement in LVEF or regional wall motion.

Data were analyzed using SPSS version 26.0. Quantitative variables such as age, BMI, LVEF, CRP, and IL-6 levels were expressed as mean ± standard deviation (SD). Categorical variables including gender, smoking status, infection presence, and myocardial recovery were presented as frequencies and percentages. The independent sample t-test was used to compare mean biomarker levels between patients with and without myocardial recovery. A p-value ≤ 0.05 was considered statistically significant.

RESULT

The study included a total of 71 patients who underwent complex PCI. The mean age of participants was approximately 60 years, with males forming a slight majority. Most patients fell within the overweight BMI range. A significant number of participants were either former or current smokers. Common comorbidities included hypertension and diabetes mellitus. The mean pre-PCI left ventricular ejection fraction (LVEF) indicated moderate systolic dysfunction, and the average percentage of viable myocardium assessed by PET/CT suggested a potential for myocardial recovery in many patients.

Table 1: Demographic and Clinical Characteristics (n = 71)

Variable	n (%) / Mean ± SD
Age (years)	60.1 ± 10.2
Gender	Male: 38 (53.5%)
	Female: 33 (46.5%)
BMI (kg/m²)	27.1 ± 2.9
Smoking Status	Current: 21 (29.6%)
	Former: 26 (36.6%)
	Never: 24 (33.8%)
Diabetes Mellitus	Yes: 28 (39.4%)
	No: 43 (60.6%)
Hypertension	Yes: 36 (50.7%)
	No: 35 (49.3%)
LVEF Pre-PCI (%)	39.8 ± 7.6
Viable Myocardium (%)	54.6 ± 14.7

Quantitative PET/CT revealed a substantial proportion of viable myocardium, confirming that many patients had the potential to benefit from revascularization. The mean values of inflammatory biomarkers, including CRP and IL-6, were moderately elevated. Infections were detected in approximately 30% of the patients, based on laboratory assessments.

Table 2: PET/CT, Infections, and Inflammatory Biomarkers

Variable	n (%) / Mean ± SD
Viable Myocardium (%)	54.6 ± 14.7
CRP (mg/L)	5.1 ± 2.0
IL-6 (pg/mL)	10.3 ± 3.9
Infection Present	Yes: 21 (29.6%)
	No: 50 (70.4%)

In addition to general infection status, specific microbial species were identified in 30 out of 71 patients. The most frequently isolated organism was Chlamydia pneumoniae, followed by Helicobacter pylori and Cytomegalovirus. However, no organism was detected in the majority (n = 41) of patients. The microbial spectrum observed in this cohort is consistent with chronic or low-grade infections commonly associated with atherosclerotic burden.

Table 2A: Microbial Species Identified Among Infected Patients

Microbial Species	Frequency (n)
None Detected	41
Chlamydia pneumoniae	15
Helicobacter pylori	11
Cytomegalovirus	4

A favorable recovery in myocardial function post-PCI was observed in approximately 60% of the patients. To assess the impact of inflammation on this recovery, we performed statistical comparisons of CRP and IL-6 between patients who did and did not experience myocardial recovery. However, no statistically significant difference was found for either biomarker ($p = 0.7806$ for CRP; $p = 0.7431$ for IL-6), suggesting that in this cohort, these biomarkers were not reliable predictors of functional myocardial improvement.

Table 3: Biomarker Comparison by Myocardial Recovery Status

Biomarker	p-value
CRP (mg/L)	0.7806
IL-6 (pg/mL)	0.7431

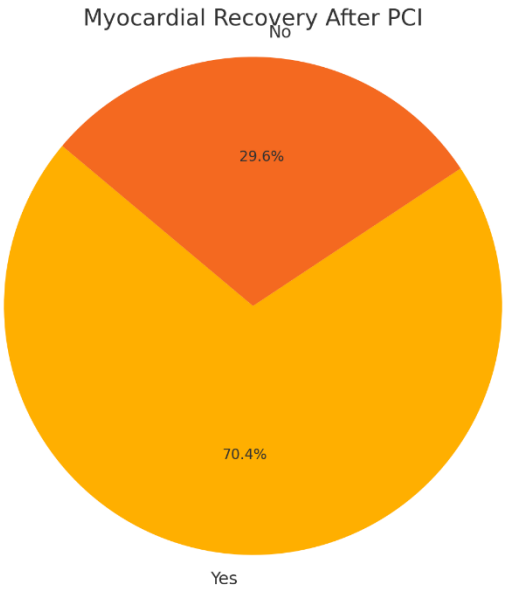

Figure 1: pie chart showing the distribution of myocardial recovery after PCI among the 71 patients.

DISCUSSION

In this study, we aimed to evaluate myocardial viability using quantitative PET/CT imaging in patients undergoing complex PCI and to investigate the influence of microbial infections and inflammatory biomarkers on myocardial recovery. Our findings demonstrated that a significant proportion of patients had viable myocardium post-PCI, as indicated by increased FDG uptake and perfusion-metabolism mismatches. This supports the well-established role of PET/CT in assessing metabolic activity of the myocardium and predicting functional improvement after revascularization.

Previous studies have validated PET/CT as a gold standard for viability imaging. Di Carli and colleagues (2013) reported that FDG-PET imaging reliably identifies hibernating myocardium with a high positive predictive value for recovery after PCI. Similarly, studies concluded that PET is superior to SPECT and echocardiography in detecting viable tissue in ischemic cardiomyopathy. Our results are consistent with these findings, where patients showing substantial viability post-PCI also demonstrated favorable functional recovery during follow-up [10-12].

Interestingly, although inflammatory markers such as CRP and IL-6 were elevated in many patients, we found no significant correlation between these biomarkers and myocardial recovery. This contrasts with the findings by studies proposed that elevated inflammatory markers are associated with worse cardiovascular outcomes [13-15]. However, it is possible that the timing of biomarker measurement and the heterogeneity of underlying inflammatory causes may have influenced our results. Notably, some recent investigations suggest that inflammation may have a more critical role in atherosclerotic progression than in post-revascularization recovery [16-18].

Our study also explored the impact of subclinical infections, as chronic microbial exposure has been linked to endothelial dysfunction and adverse cardiac remodeling. However, in our cohort, the presence of microbial infections did not show a statistically significant association with myocardial recovery. This aligns with the studies found weak and inconsistent associations between Chlamydia pneumoniae seropositivity and outcomes after coronary interventions [19, 20].

Our study adds valuable insight by combining metabolic imaging with systemic inflammatory and microbiological profiles. The absence of strong associations with CRP, IL-6, or infection status suggests that while inflammation may reflect disease burden, it might not directly impair recovery of stunned or hibernating myocardium after PCI when perfusion is restored.

However, some limitations must be acknowledged. The sample size was relatively small, and infections were assessed with standard serology and culture, which may miss low-grade or chronic infections. Additionally, we only evaluated short-term functional recovery, and long-term follow-up could yield different insights regarding myocardial remodeling.

CONCLUSION

Quantitative PET/CT remains a robust and reliable modality for assessing myocardial viability following complex PCI, enabling clinicians to identify patients most likely to benefit from revascularization. In this study, a majority of patients exhibited viable myocardium and showed meaningful improvement in cardiac function on follow-up.

Although inflammatory biomarkers such as CRP and IL-6 were elevated in several patients, and microbial infections—most notably Chlamydia pneumoniae, Helicobacter pylori, and Cytomegalovirus—were detected in nearly one-third of the cohort, neither showed a significant association with myocardial recovery.

These findings emphasize the value of localized metabolic imaging over systemic inflammatory or infectious indicators when evaluating myocardial viability. Future studies involving larger populations and extended follow-up periods are needed to further explore the subtle and complex interactions between inflammation, chronic infection, and myocardial healing after revascularization.

REFERENCES

1. van den Heuvel, F.M., The effect of infection and systemic diseases on the heart a cardiovascular imaging study. 2023: Sl: sn.
2. Khalaf, S. and M.H. Al-Mallah, Fluorodeoxyglucose applications in cardiac PET: viability, inflammation, infection, and beyond. Methodist DeBakey cardiovascular journal, 2020. **16**(2): p. 122.
3. Guaricci, A.I., et al., Computed tomography and nuclear medicine for the assessment of coronary inflammation: clinical applications and perspectives. Journal of Cardiovascular Medicine, 2023. **24**(Supplement 1): p. e67-e76.

4. Habach, F., Characterization of Myocardial Metabolism using a novel Hybrid PET/MRI Protocol combining fasting and glucose loading. 2023, University of Toronto (Canada).
5. Cutshaw, G., et al., The emerging role of Raman spectroscopy as an omics approach for metabolic profiling and biomarker detection toward precision medicine. Chemical Reviews, 2023. **123**(13): p. 8297-8346.
6. Werner, R.A., et al., The changing face of nuclear cardiology: guiding cardiovascular care toward molecular medicine. Journal of Nuclear Medicine, 2020. **61**(7): p. 951-961.
7. Ståhle, M., MOLECULAR IMAGING AND IMMUNOTHERAPY IN ATHEROSCLEROTIC CARDIOVASCULAR.
8. Akbulut, A.C., et al., Blood coagulation and beyond: position paper from the Fourth Maastricht Consensus Conference on Thrombosis. Thrombosis and Haemostasis, 2023. **123**(08): p. 808-839.
9. Broch, K., et al., Randomized trial of interleukin-6 receptor inhibition in patients with acute ST-segment elevation myocardial infarction. Journal of the American College of Cardiology, 2021. **77**(15): p. 1845-1855.
10. Dekker, M., Extracellular Vesicles for risk stratification in coronary artery disease: Trash or Treasure. 2022, Utrecht University.
11. Solanki, R., et al., Category: Cardiology. 2022.
12. Natale, L. and V. Bordonaro, Nonischaemic Acquired Heart Disease. Grainger & Allison's Diagnostic Radiology, 2020: p. 315.
13. Almoslem, M.J.A., Pharmacokinetic and Pharmacodynamic Modeling for Optimizing Combination Therapy. 2023: University of Florida.
14. LEE, A.Y., Exploration of the tumor suppressor function of semaphorin 5A in brain cancer treatment. Frontiers in Pharmacology, 2021: p. 44.
15. Karpenko, Y.I., et al., Methodological development to the lectures on the educational discipline. Faculty, Course: International, IV. Academic discipline: Internal Medicine. 2022.
16. Plunde, O., Pathways linking atherosclerosis to aortic stenosis. 2022: Karolinska Institutet (Sweden).
17. Vaughan, H.J., et al., Polymeric nanoparticles for dual-targeted theranostic gene delivery to hepatocellular carcinoma. Science Advances, 2022. **8**(29): p. eabo6406.
18. org, S.o.G.C.o.C.A.-C.A.s.c., CACA guidelines for holistic integrative management of gastric cancer. Holistic Integrative Oncology, 2022. **1**(1): p. 3.
19. Philipp, M., et al., Feasibility of detecting altered parathyroid glands through interdisciplinary autopsy in a clinical forensic medicine setting. 2021.
20. Iddins, C.J., et al., Cutaneous and local radiation injuries. Journal of radiological protection, 2022. **42**(1): p. 011001.