Paradoxical Myocardial Perfusion Imaging Pattern in Cardiac Patient: Two Case Reports

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ABSTRACT

To evaluate myocardial blood flow and identify regions of ischemia or infarction, Myocardial Perfusion Imaging (MPI) is a useful diagnostic technique. It relies on the identification of perfusion anomalies, which are related to underlying coronary artery disease and usually appear as regions of reduced blood flow. However, the appearance of paradoxical perfusion patterns in MPI raises doubt on the accepted interpretation of these imaging findings.

Unexpected results in MPI are known as "paradoxical perfusion patterns," where regions of increased perfusion are found in places where decreased blood flow would be expected based on clinical presentation and conventional risk factors. Clinicians are faced with a diagnostic dilemma as a result of the unusual phenomena that have been documented in only a small number of cases.

We are presenting two case reports that describe a paradoxical perfusion pattern seen during MPI. These cases raise questions about the traditional interpretation of MPI data and emphasize how crucial it is to take anatomical variations and collateral circulation into consideration when interpreting the results of perfusion imaging. Understanding the causes behind paradoxical patterns of perfusion is essential for proper diagnosis and appropriate therapeutic management, as it may affect treatment methods and prognosis.

The reported cases conclude by emphasizing the need for careful interpretation of MPI findings to point out possible paradoxical perfusion patterns, which could be a symptom of particular anatomical differences.

Keywords: Myocardial perfusion, paradoxical pattern, coronary artery disease, myocardial infarction, myocardial viability, stress tests

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INTRODUCTION

Non-invasive investigations play an important role in the early diagnosis of coronary artery disease. Myocardial perfusion imaging (MPI) is one of the most commonly performed non-invasive cardiac imaging procedures (1). MPI plays a key role in diagnosing cardiovascular disease, establishing prognosis, assessing the effectiveness of therapy, and evaluating viability (2). Typical patterns appearing in scintigraphic images are: (a) stress perfusion defects totally reversible at rest; (b) stress perfusion defects partially reversible at rest; and (c) stress perfusion defects without reversibility at rest (i.e., fixed defects) (3). Paradoxical myocardial perfusion imaging (MPI) patterns or reverse redistribution patterns in cardiac patients are rare but significant findings that can have important clinical implications. The paradoxical MPI pattern is characterized by abnormal perfusion of the heart muscle, where there is higher tracer uptake at stress than at rest. It is typically observed in patients with balanced ischemia or collateral circulation. These case reports highlight the significance of paradoxical MPI patterns in cardiac patients and emphasize the importance of proper diagnostic evaluation and management.

Case 1

A 53-year-old male patient was referred to our department with a complaint of central and left sided dyspnea during strenuous activities despite optimal medical therapy. There was no history of symptoms at rest and also at the time of presentation. However, patient was hypertensive with positive family history of sudden cardiac death of brother. In 2012, an event of myocardial infarction (MI) followed by coronary angiogram (CAG) which revealed 80% stenosis in Left Anterior Descending (LAD) Artery. Eventually; the patient had undergone percutaneous coronary intervention (PCI) of LAD in the same year. Resting electrocardiogram (ECG) revealed sinus tachycardia with left axis deviation and echocardiogram found dilated left ventricular cavity with akinetic apex and anterior wall. Ejection fraction (EF) was 35% on echocardiogram. Physical examination was unremarkable with a heart rate of 74 beats/minute, normal blood pressure (125/75 mmHg), respiratory rate of 16 breaths /minute and an oxygen saturation of 98 The patient underwent 99mTc-Sestamibi stress/rest gated SPECT myocardial perfusion imaging using a 1-day protocol in July, 2023 at NINMAS. Pharmacological stress was done with Dobutamine following standard mayo clinic protocol. 99mTc-Sestamibi was administered intravenously during peak heart rate and infusion was continued for further one minute. Post- stress SPECT acquisition with gating was done. Rest study using the same Acquisition method was done later on the same day. MPI revealed small area of reduced perfusion at LAD territory at stress but large area of perfusion defect was detected at rest. Mild hypokinesia of inferior and septal wall was observed at rest. (Figure 1)

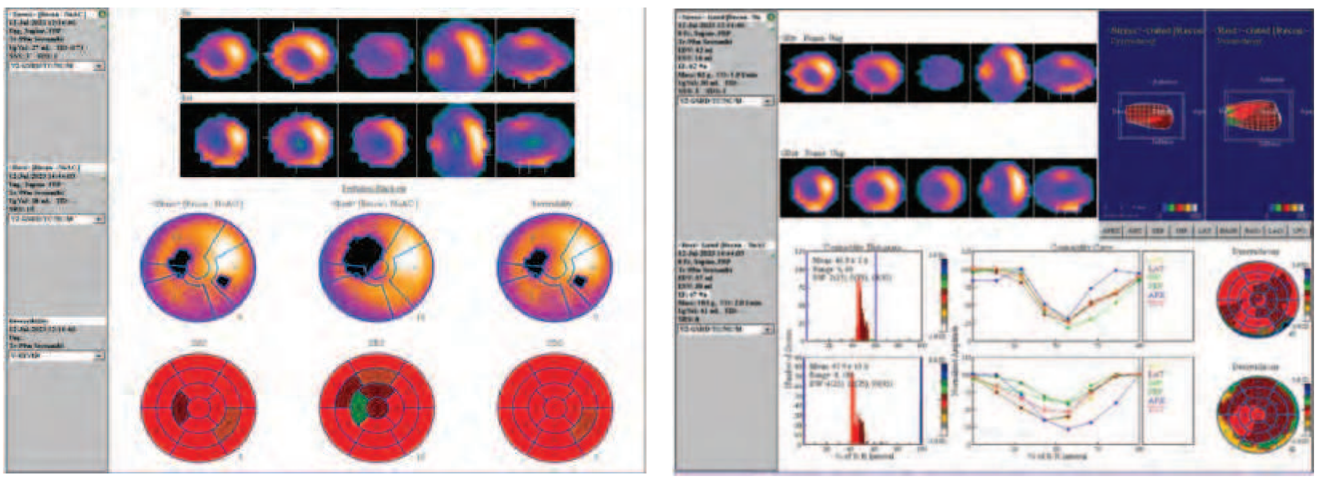

Figure 1: 99m-Tc MIBI myocardial perfusion scan image of a 59-year-old male A. showing small area of reduced perfusion at LAD territory at stress but large area at rest (yellow arrow); B. Left ventricular wall motion curve showing mild hypokinesia of inferior and septal wall at rest (orange arrow).

Case 2

A 60-year-old female patient was referred to nuclear cardiology division of NINMAS with complaints of central dyspnea on exertion despite optimal medical therapy. There was no history of resting symptoms and was asymptomatic at the time of presentation. Previous medical history included hypertension and a positive

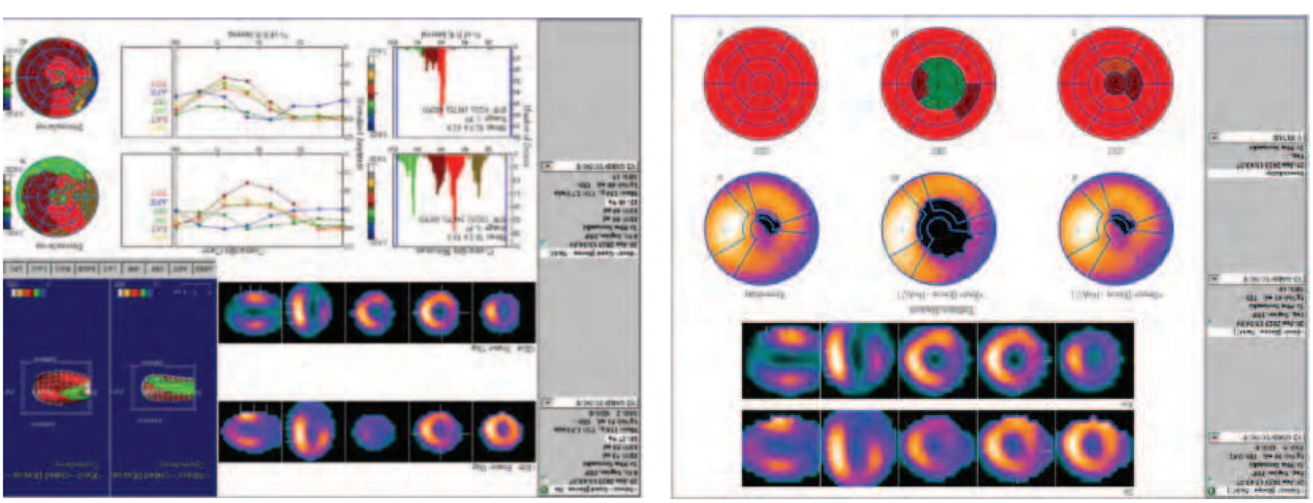

Figure 2: Myocardial perfusion scan of a 60-year-old female showing A. very small area of reduced perfusion at LAD territory at stress (yellow arrow) but triple vessel territory perfusion defect at rest (orange arrow); B. Left ventricular wall motion curve showing dyskinesia of apex and septal wall both at stress and rest (red arrow).

In both patients the perfusion pattern on MPI may suggest myocardial necrosis with paradoxical pattern. Also the left ventricular wall motion curve of both patients showed dyskinetic apex and septal wall both at stress and rest.

DISCUSSION

Myocardial perfusion imaging (MPI) is crucial for managing cardiovascular diseases as it allows for diagnosis, prognosis assessment, therapeutic efficacy evaluation, and viability assessment. Most MPI studies nowadays use SPECT and ECG gating (2). Pharmacological stress testing is common, especially for patients unable to exercise due to various medical conditions. Vasodilators like adenosine or dipyridamole are commonly used for pharmacologic stress, enhancing diagnostic precision, particularly when combined with exercise stress testing. This approach is vital for patients with conditions limiting their ability to exercise or achieve maximal exertion during testing, ensuring comprehensive evaluation even in challenging cases (3).

In a typical normal myocardial perfusion imaging, uniform radiotracer distribution is observed in stress and rest images. Abnormal perfusion patterns strongly indicate coronary artery disease (CAD). Decreased radiopharmaceutical activity on post-stress images that improves or disappears on rest images indicates reversibility of a perfusion deficit, suggesting ischemia. Fixed defects do not show activity variations between stress and rest images. Large fixed defects typically indicate scar tissue from a previous myocardial infarction (MI) while a mild or moderate fixed defect could be an indication of a hibernating myocardium or a previous nontransmural MI (4).

The stress-rest MPI findings in both the reported cases are not typical rather showing higher tracer activity during stress than rest images suggesting paradoxical pattern (PP). Pizzi, M.N et al reviewed 1764 SPECT MPI studies with history of prior MI and found 6.6% of individuals with myocardial necrosis having paradoxical pattern (5). The study described that segment having a PP pattern met scintigraphic criteria for viability. These segments are evaluated on stress images, where uptake is by definition higher than at rest. Due to the culprit artery's patency or the presence of homocoronary or heterocoronary collateral circulation to this territory when the coronary artery is closed, necrotic zones with a PP have retained myocardial perfusion which is typically observed in patients with balanced ischemia or collateral circulation (5).

A potential myocardial necrosis with a paradoxical pattern is found in both the reported cases. This paradoxical pattern could be attributed to either the presence of collateral circulation to the area affected by an occluded artery or the continued patency of the artery despite occlusion. In these two cases, the patient had prior PCI to the left anterior descending artery, which likely led to the development of well-developed collateral vessels supplying blood to the territory of the anterior wall. It is agreed by report of Fathala A which mentioned that post MI reverse redistribution has been documented especially after revascularization or thrombolytic therapy.

PP is found in post-MI individuals who have undergone reperfusion having some subendocardial scarring that is still present, but also with myocardial salvage and a patent infarct vessel. The subepicardial layers' hyperemic flow during stress imaging of these patients enables more tracer absorption in this area than on resting images as shown in the reported cases. The scar is seen in the resting images, along with viable areas that have tracer uptake associated with resting flow. The subepicardial portion of the PP exhibit greater tracer uptake during hyperemic flow on stress imaging because the flow reserve in these viable areas is conserved. Therefore, the scar is the same size under both stress and rest; on the stress imaging, the elevated counts in these viable regions in the subepicardial simply "shine through" into the subendocardial scar area. As a result, the scar size appears smaller, and the overall transmural counts are higher on stress than on rest images (5).

A small percentage of patients with myocardial necrosis show paradoxical myocardial necrosis (PP). Individuals with a PP pattern on MPI using Tc-99m-labeled tracers are more likely to survive and have better LV function than individuals with a non-PP pattern in necrotic myocardial regions (6).

The left ventricular wall motion curve of the reported cases showed dyskinetic apex and septal wall both at stress and rest. Pace et al in assessing wall motion with 2D ultrasound before and after revascularization, also concluded that PP in dyskinetic segments was suggestive of myocardial viability, since contractility improved after surgery. It has been suggested that one of the most probable explanations for the reverse redistribution phenomenon in patients with chronic CAD is the presence of an admixture of scar and viable myocardium in the same segment (7).

Paradoxical MPI patterns can present a diagnostic challenge but should not be overlooked. They offer valuable insights into the complex interplay between coronary anatomy, perfusion, and myocardial viability. Careful evaluation of these patterns can lead to the identification of rare anatomical variants or other underlying pathologies.

CONCLUSION

Despite being very uncommon, paradoxical MPI patterns can provide valuable insights into the underlying pathophysiology of cardiovascular diseases. This phenomenon challenges the established norms and distribution patterns typically observed in specific clinical scenarios. It refers to a pattern where the distribution of perfusion abnormalities on MPI scans is unexpected or contrary to what would be typically observed in a particular patient population. Knowledge of these atypical findings is paramount in order to avoid misinterpretation and ensure accurate diagnosis and subsequent management. This case report highlights the significance of the paradoxical MPI pattern in cardiac patients and emphasizes the importance of proper diagnostic evaluation and management.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding publication of this paper.

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