DOI : https://doi.org/10.3329/bjnm.v27i1.71513

^{18}F FDG PET Cardiac Imaging for Myocardial Viability Assessment in NINMAS

[1]Tapati Mandal, [2] Sadia Sultana, [3] Shamim MF Begum, [4] Sajal K. Banerjee, [5] Chowdhury Meshkat Ahmed

[1]Assistant Professor & SMO, National Institute of Nuclear Medicine & Allied Sciences (NINMAS)

[2] Professor and Ex Director, NINMAS

[3] Professor and Member, Planning, Bangladesh Atomic Energy Commission.

[4] Professor of Cardiology, Bangladesh Bangabandhu Sheikh Mujib Medical University (BSMMU).

[5] Professor and Chairman of Cardiology, Bangabandhu Sheikh Mujib Medical University (BSMMU).

Correspondence Address: Dr. Tapati Mandal, Assistant Professor and Head, Nuclear Cardiology Division, National Institute of Nuclear Medicine & Allied Sciences (NINMAS), BSMMU campus, Dhaka, E-mail: tapatinm@gmail.com

Patients who have multi-vessel coronary artery disease (CAD) or left ventricular (LV) dysfunction usually benefited significantly from revascularization such as coronary artery bypass grafting (CABG) or percutaneous coronary intervention (PCI), formerly known as angioplasty with stent. However, these high-risk patients are more prone to complications during revascularization procedures. Therefore, appropriate patient selection is very much important and should be done by thorough evaluation of potential risks and benefits. Simply assessing the anatomical severity of coronary stenosis by coronary angiography (CAG) may not be sufficient for making clinical decisions. Prognosis does not improve with revascularization in cases of functionally insignificant coronary artery stenosis rather is excessively costly and potentially harmful due to the considerable risk of periprocedural myocardial infarction or subacute stent thrombosis, even with the use of drug-eluting stents (1). In this regard, Myocardial Perfusion Imaging (MPI) is a well-established and important tool which is indicated for risk stratification, detection, evaluation and prognosis of coronary artery disease (CAD) (2,3). Stress-rest single photon emission computed tomography (SPECT) gated MPI is performed to determine myocardial ischemia and/or **myocardial infarction** as well as left ventricular function. Myocardial ischemia refers to the stress induced regional perfusion defect that resolves completely or partially at rest images. On the other hand, if the defect in stress images persists in the rest images it suggests fixed perfusion defect or myocardial **infarction** (3).

National Institute of Nuclear Medicine and Allied sciences (NINMAS) being pioneer in nuclear cardiology in Bangladesh introduced Gated SPECT stress-rest MPI in 2001, performing regularly since 2004 to evaluate CAD thus aid in management of patient.

In case of stress induced reversible perfusion defect in MPI the coronary intervention is undoubtedly beneficiary as recovery of regional function after revascularization is well established (4). However, decision making for intervention in cases of fixed perfusion defects detected by MPI is critical because in some cases because within the fixed defect a significant percentage (up to 50%) of myocardium might be viable but hibernating. The presence of viability is indicative of the potential recovery of wall motion function in the affected segments after revascularization, while the absence of viability correlates with no recovery of myocardial function (5,6). Therefore, assessment of myocardial viability such as 'stunned' or 'hibernating myocardium' is crucial in determining the possibility of functional recovery in patients with coronary artery disease (CAD) and left ventricular failure.

Cardiac Positron Emission Tomography (PET) has emerged as a powerful tool in the assessment of myocardial viability providing valuable information about the functional status of the heart. The ability to accurately assess myocardial viability with high sensitivity (95%) and specificity (80%) enhances diagnostic precision, directing treatment of choice and improving patient outcomes (7). The patients with non-viable myocardium are also

Table 2: Guidelines for BG maintenance (after glucose administration) for optimal ^{18}F FDG cardiac uptake, BG of approximately 100-140 mg/dL (5.55-7.77 mmol/L) at time of injection of ^{18}F FDG

130-140 mg/dL (7.22-7.78 mmol/L) 1U regular insulin IV	**130-140 mg/dL (7.22-7.78 mmol/L) 1U regular insulin IV**
140-160 mg/dL (7.78-8.89 mmol/L)	2U regular insulin IV
160-180 mg/dL (8.89-10 mmol/L)	3U regular insulin IV
180-200 mg/dL (10-11.11 mmol/L)	5U regular insulin IV
>200 mg/dL - (>11.11 mmol/L)	Notify physician

BG = blood glucose; FDG = fluorodeoxyglucose; IV = intravenous; mg = milligram; mmol = millimoles; L = liter; dL = deciliter; U = unit

INTERPRETATION

Interpretation is made after analyzing ^{18}F-FDG metabolic images in conjunction with perfusion images, obtained with SPECT gated rest MPI (10). Perfusion-metabolism mismatched defect suggests viable hibernating myocardium, perfusion-metabolism matched defect suggests non-viable myocardium and normal perfusion-normal metabolism suggests normal viable myocardium. The pattern is summarized below in Table 3 (10).

Table 3: Interpretation of myocardial perfusion and glucose loaded ^{18}F FDG pattern

Myocardial blood flow	^{18}F-FDG uptake	Interpretation
Normal	Normal	Normal
Reduced	Preserved or enhanced ^{18}F-FDG uptake	Perfusion-metabolism mismatch
Normal or near normal	Reduced 18F-FDG uptake	Reversed perfusion - metabolism mismatch May occur in the septum of patients with LBBB (6)
Proportionally reduced	Proportionally reduced ^{18}F - FDG uptake	Perfusion-metabolism match

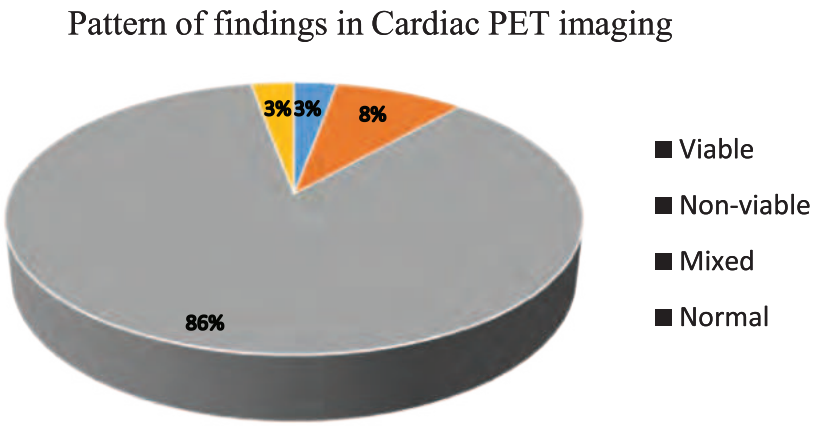
The first 3 patterns represent viable myocardium. Only the last pattern, where both perfusion and metabolism defects are matched, represents nonviable (scarred) tissue

Cardiac PET imaging in NINMAS

The first patient was done successfully in 2019 but the Covid-19 pandemic snatched a couple of years from us. We started again in 2022 and a total of 35 patients were done till December'2023. The table 4 and pie chart below overview the data. Figure 1 & Figure 2 show two cases done at NINMAS with viable and non-viable myocardium.

Table 4: Pattern of findings in Cardiac PET imaging in NINMAS

Year	Number	Viable	Non-viable	Mixed	Normal
2019	1			1	
2022	16	1	4	11	
2023	18	-	3	14	1
Total	35	1	7	26	1



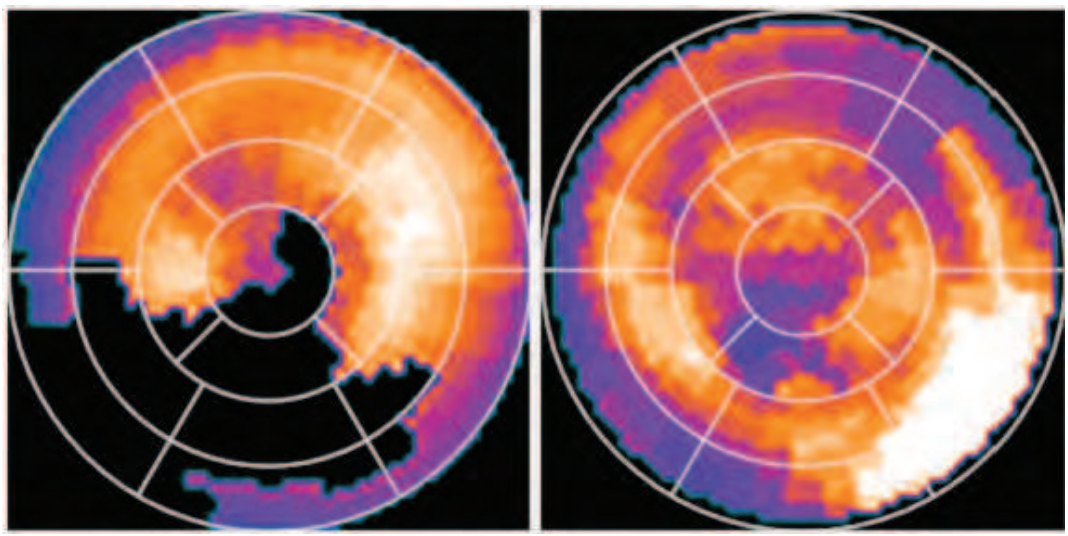


Figure 1: A 45 years male with H/O inferior MI, Echo: EF-42%, moderately hypokinetic inferior wall. 18F FDG PET- Perfusion-metabolism mismatched defect in RCA territory suggested hibernating myocardium. Rx: CABG F/U: Improved EF (48%) and wall motion.
(EF-Ejection fraction; CABG-Coronary Artery Bypass Grafting)

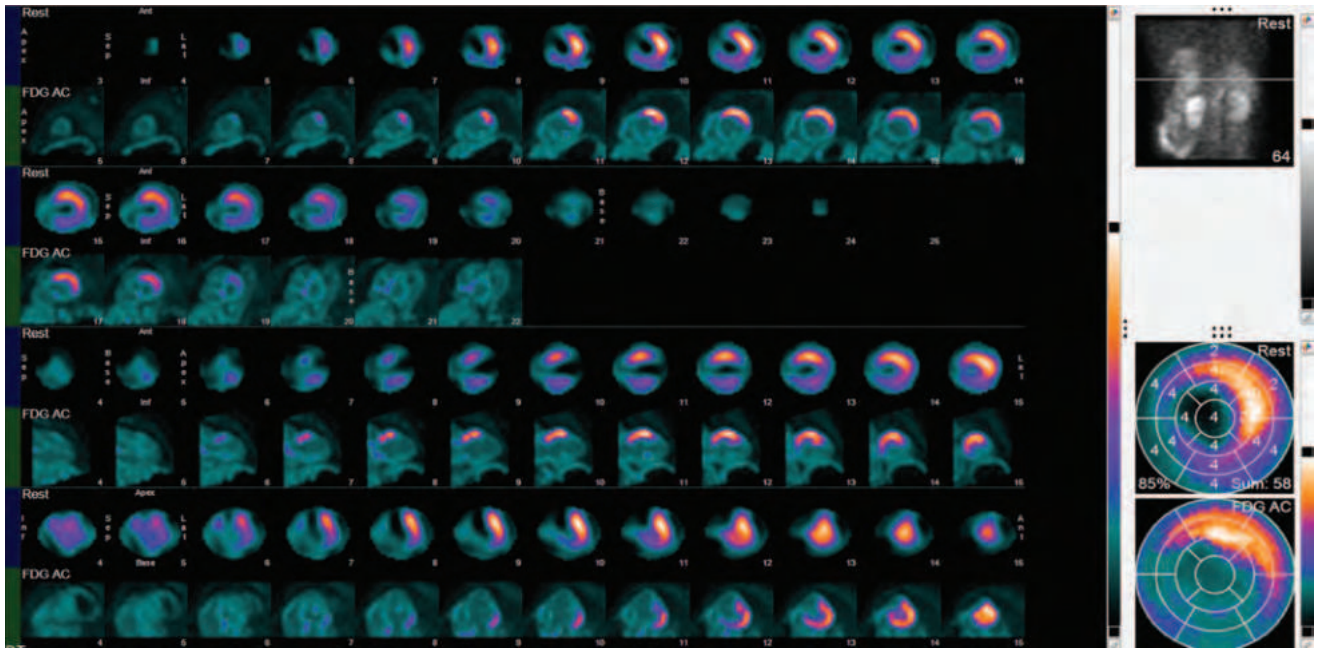


Figure 2: A 58 years old male having TVD on CAG, Echo: EF-28% with marked global hypokinesia. ^{18}F FDG PET: Perfusion-metabolism matched defect in triple vessel territories suggested non-viable myocardium. Rx: Not recommended for revascularization, on medication. (TVD-Triple vessel disease)

CONCLUSION

18F FDG PET cardiac viability scan is routinely done in NINMAS. The integration of this procedure into clinical practice marks a significant advancement in cardiac imaging as it can potentially assess myocardial viability guiding therapeutic decisions.

LIMITITATIONS

The outcome evaluation is limited due to short data. However, a more extensive evaluation is planned for the future with large group of data.

ACKNOWLEDGEMENT

Thanks to the tireless efforts of Prof. Nurul Islam and Prof. Ferdoushi Begum, as well as constant technical assistance from Mr. Khokon Kumar Nath. I am grateful to Prof Dr. Md. Abu Bakker Siddique, Dr. Pupree Mutsuddy and Dr. Papia Akhter for their continual support. Appreciation goes to Doctors of NINMAS & Department of Cardiology, BSMMU. My heartful gratitude to Prof. Dr. Fatima Begum, Director NINMAS who inspired me to write the article.

REFERENCES

1. Pijls, N.H., van Schaardenburgh, P., Manoharan, G., Boersma, E., Bech, J.W., van't Veer, M., Bär, F., Hoorntje, J., Koolen, J., Wijns, W. and de Bruyne, B., 2007. Percutaneous coronary intervention of functionally nonsignificant stenosis: 5-year follow-up of the DEFER Study. Journal of the American College of Cardiology, 49(21), pp.2105-2111.
2. Manabe, O., Aikawa, T., Naya, M., Miura, S. and Oyama-Manabe, N., 2021. Functional Assessment of Coronary Artery Disease by Myocardial Flow Reserve Versus Pressure-wire Based Assessment A Systematic Review. Annals of Nuclear Cardiology, 7(1), pp.57-62.
3. Rodríguez-Granillo, G.A., Ingino, C.A. and Lylyk, P., 2010. Myocardial perfusion imaging and infarct characterization using multidetector cardiac computed tomography. World Journal of Cardiology, 2(7), p.198.
4. Strauss, H.W., Miller, D.D., Wittry, M.D., Cerqueira, M.D., Garcia, E.V., Iskandrian, A.S., Schelbert, H.R., Wackers, F.J., Balon, H.R., Lang, O. and Machac, J., 2008. Procedure guideline for myocardial perfusion imaging 3.3. Journal of Nuclear Medicine Technology, 36(3), pp.155-161.)
5. Dilsizian, V., 2021. Interpretation and clinical management of patients with "Fixed" myocardial perfusion defects: a call for quantifying endocardial-to-epicardial distribution of blood flow. Journal of Nuclear Cardiology, 28, pp.723-728.
6. Mettler Jr, F.A. and Guiberteau, M.J., 2012. Essentials of nuclear medicine imaging: expert consult-online and print ch 5 Elsevier Health Sciences.
7. Luigi, M., 2022. Janis O'Malley and Harvey Ziessman (eds): Nuclear medicine and molecular imaging: the requisites ch 16. European Journal of Nuclear Medicine and Molecular Imaging, 49(7), pp.2105-2105.
8. LibbeyP, B.R., Mann, D.L. and Zipes, D.P., 2007. Braunwald's heart disease: A textbook of cardiovascular medicine (2018 Elsevier) ch 16, pp 291-294
9. Zaret, B.L. and Beller, G.A., 2010. Clinical nuclear cardiology: state of the art and future directions.
10. Dilsizian, V., Bacharach, S.L., Beanlands, R.S., Bergmann, S.R., Delbeke, D., Dorbala, S., Gropler, R.J., Knuuti, J., Schelbert, H.R. and Travin, M.I., 2016. ASNC imaging guidelines/SNMMI procedure standard for positron emission tomography (PET) nuclear cardiology procedures. Journal of Nuclear Cardiology, 23, pp.1187-1226.
11. www.asnc.org/practicepoints
12. Manapragada, P.P., Andrikopoulou, E., Bajaj, N. and Bhambhvani, P., 2021. PET cardiac imaging (perfusion, viability, sarcoidosis, and infection). Radiologic Clinics, 59(5), pp.835-852.
13. Srivatsava, M.K., Indirani, M., Sathyamurthy, I., Sengottuvelu, G., Jain, A.S. and Shelley, S., 2016. Role of PET-CT in the assessment of myocardial viability in patients with left ventricular dysfunction. Indian heart journal, 68(5), pp.693-699.