

The Significance of TID in Subendocardial Ischemia or Balanced Ischemia in the Setting of an Otherwise Normal SPECT Myocardial Perfusion Imaging Study

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ABSTRACT

Objectives: The term "transient ischemic dilation" (TID) refers to the apparent significant enlargement of left ventricle (LV) on post-stress images as compared to rest images on SPECT radionuclide myocardial perfusion imaging (MPI). In presence of abnormal SPECT MPI, transient ischemic dilatation (TID) is regarded as a sign of severe and widespread coronary artery disease (CAD) with poor prognosis. However, high TID is also observed with normal MPI. The possible explanations are balanced epicardial CAD, diffuse microvascular disease or widespread subendocardial ischemia which would be associated with adverse outcomes. TID has been identified as a significant indication of severe and widespread CAD and predictive of a high risk of cardiac events. However, the clinical relevance of TID and its relationship with CAD in individuals with an otherwise normal MPI exam is unknown.

Patients & Methods: This observational study was conducted in Nuclear Cardiology division of National Institute of Nuclear Medicine & Allied Sciences (NINMAS), BSMMU campus, Dhaka from January 2023 to December 2023. Out of a total of 178 patients who underwent stress-rest SPECT-MPI in the nuclear cardiology division, ten patients were identified with normal perfusion scans but exhibited high TID values. The TID index was calculated based on published threshold values with >1.12 denoting high TID. Almost all the patients went through coronary angiogram (CAG) within six months and had positive findings. This study aimed to investigate the relationship between TID and the presence or severity of coronary artery disease (CAD) in angiography.

Results: Among the ten patients having normal perfusion but high TID, there is male predominance. Age ranges from 34 to 74 years. Nine out of ten patients had undergone previous coronary angiography (CAG) within a six-month timeframe, revealing triple vessel disease (TVD) in five patients (50%), double vessel disease (DVD) in three patients (30%), and single vessel disease (SVD) in one patient (10%). One patient did not have any CAG. The patients with TVD and two DVDs on CAG were obstructive CAD which was defined as diameter stenosis of 50% or more in the left main coronary artery or stenosis of 70% or more in a major epicardial vessel. The remaining patients were diagnosed with nonobstructive CAD based on angiogram findings.

Conclusions: In this observational study, the clinical relevance of obstructive CAD is highlighted by the presence of high TID accompanied

with otherwise normal SPECT MPI, which reveals the existence of CAD and predicts a significant risk of cardiac events.

Keywords: Transient ischemic dilatation, Gated SPECT MPI, coronary angiography, coronary artery disease.

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INTRODUCTION

For the assessment of patients with suspected or confirmed coronary artery disease (CAD), stress myocardial perfusion imaging (MPI) with single-photon emission computed tomography (SPECT) is a well-respected noninvasive imaging method. A sign of severe CAD is transient ischemic dilation (TID). Even in cases when myocardial perfusion is normal, TID is a strong indicator of severe CAD and also a predictor of subsequent cardiac events. The aim of our study was to evaluate the diagnostic value of TID in selected patients with known significant CAD, recent coronary revascularization, and recurrence of symptoms. The significance of TID in patients with otherwise normal MPI images is not clear, but there is a considerable chance of balanced ischemia from multivessel CAD in such cases, as indicated by several studies. On coronary angiography, we looked at the connection between the amount and severity of CAD and the presence or absence of TID.

PATIENTS AND METHOD

This observational study investigated the relationship between TID and the presence or severity of coronary artery disease (CAD) in angiography. This study was conducted at the Nuclear Cardiology division of the National Institute of Nuclear Medicine & Allied Sciences (NINMAS), BSMMU

campus, Dhaka, and the study population included patients who underwent stress radionuclide MPI at this institution between 2022 and 2023. Convenient and purposive sampling methods were used.

STUDY PROCEDURE

Tc-99m sestamibi SPECT imaging with ECG-gating was performed using a 1-day stress-rest imaging protocol (8 mCi for stress and 24 mCi for rest was used). Stress images were acquired following exercise or pharmacological stress (adenosine/dobutamine) test & 15-30 minutes after I/V administration of Tc-99m sestamibi; resting images were acquired approximately 90 minutes after I/V administration of Tc-99m sestamibi. The standard 17-segment model was used to analyze cardiac perfusion. Segmental myocardial radiotracer uptake was measured using the conventional 5-point grading system. Global myocardial radiotracer uptake was measured using the summed stress score (SSS), summed rest score (SRS), and summed difference score (SDS). Stress-rest LV volume, LVEF, and regional wall motion are observed.

The TID index was calculated based on published threshold values with >1.12 denoting high TID. Coronary angiograms were visually and statistically analyzed utilizing an automated digital angiography and edge detection system. Significant obstructive coronary artery disease was defined as $>50\%$ stenosis in the left main coronary artery and $>70\%$ stenosis in the other epicardial coronary arteries. SPECT MPI findings were correlated to specific coronary artery territories using the 17-segment model. LAD: segments 1, 2, 7, 8, 13, 14, and 17; RCA: segments 3, 4, 9, 10, and 15; LCX: segments 5, 6, 11, 12, and 16; Left main: at least 75% of LAD and LCX territories. Patients had undergone coronary angiography (CAG) within a six-month timeframe and most of them had obstructive CAD.

RESULTS

Ten out of 178 patients were identified with normal perfusion scans but exhibited high TID values. Age ranged from 34 to 74 years with male predominance among the ten patients. Nine out of ten patients had undergone coronary angiography (CAG) within a six-month timeframe; most of them had obstructive CAD.

Table 1: Pattern of MPI findings with CAG

CAG	Number	Percentage (%)
TVD	5	50%
DVD	3	30%
SVD	1	10%
No CAG	1	10%

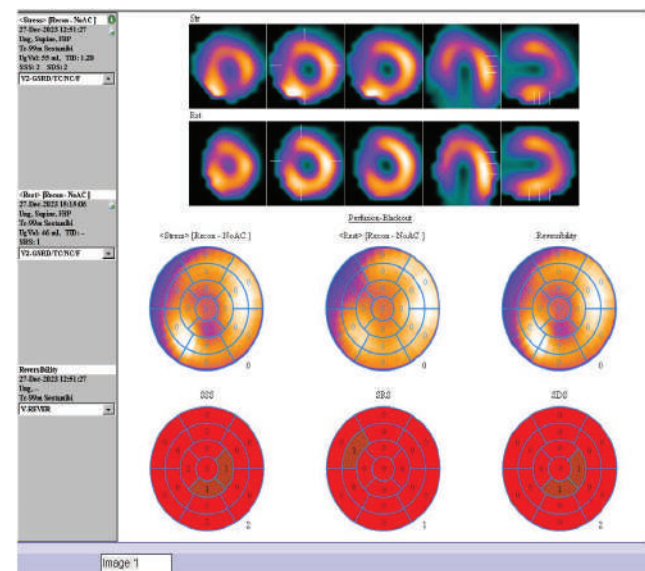


Figure 1: ^{99m}Tc -sestamibi gated SPECT Myocardial perfusion scan image showing normal perfusion.

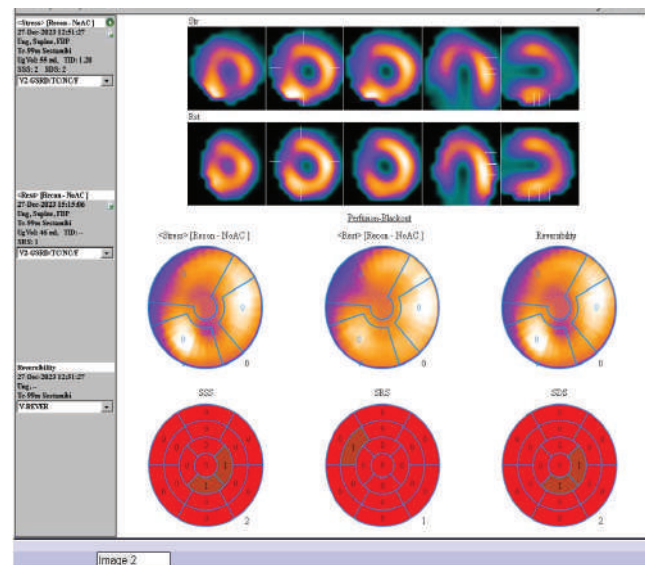


Figure 2: 17 segment ^{99m}Tc - sestamibi gated SPECT Myocardial perfusion scan image showing normal perfusion at all segments but high transient ischemic dilation (1: 20)

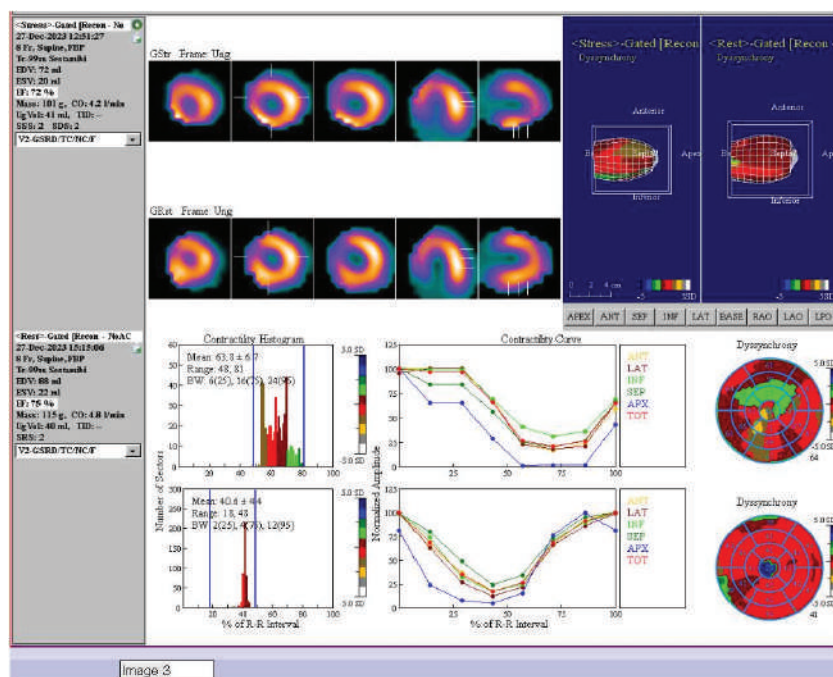


Figure 3: ^{99m}Tc sestamibi gated SPECT Myocardial perfusion scan image showing myocardial contractility curve. The curve shows normal contracted walls, EF, EDV, and ESV.

DISCUSSION

Myocardial perfusion SPECT has become a widely used tool for detecting coronary artery disease and predicting patient outcomes. This study focused on the clinical significance of coronary angiographic (CAG) findings in patients with abnormal transient ischemic dilation (TID) values, despite normal myocardial perfusion scans. Of the 10 patients identified with elevated TID values, a notable 90% underwent CAG, revealing significant coronary artery disease (CAD) in the majority. Specifically, 50% had triple-vessel disease (TVD), 30% had double-vessel disease (DVD), and 10% had single-vessel disease (SVD). One patient (10%) did not undergo CAG, emphasizing the need for further diagnostic evaluations in such cases (Table 1). These findings highlight that elevated TID is a strong indicator of severe CAD, even when conventional perfusion imaging appears normal. The high prevalence of multivessel disease (TVD and DVD collectively accounting for 80% of cases) in this cohort underscores the association between elevated TID values and extensive coronary involvement. Interestingly, the absence of CAG in one patient (10%) may reflect either logistical barriers or clinical decision-making, which could lead to the

underdiagnosis of CAD in such patients. This highlights the importance of a systematic approach to follow up on abnormal TID findings, ensuring that potential high-risk cases are not overlooked. This is consistent with prior studies that suggest TID reflects subendocardial ischemia or global ischemic burden, conditions often linked to significant multivessel CAD (3,4,6). For prognostic assessment, perfusion scintigraphy has been utilized to determine disease extent and severity, not just disease presence (5). The possible explanations of High TID with normal MPI are -balanced epicardial CAD, diffuse microvascular disease, and widespread subendocardial ischemia which would be associated with adverse outcomes (2). As it has been reported in individuals with diabetes mellitus, LV hypertrophy, and a hypertensive blood pressure response to exercise, TID is not always necessarily associated with obstructive CAD but widely accepted as it is a marker of severe and extensive CAD (1, 5). This measure can also be used as an independent predictor of a poor outcome (2). Subendocardial ischemia is most likely broad and extensive, which explains the absence of an apparent relative perfusion deficiency. On the other hand, severe and diffuse stress-induced ischemia

would be predicted to be linked to real temporary dilatation that lasts throughout the post-stress scanning period. In patients with normal perfusion, automatically calculated high TID has prognostic significance and should be taken into account in the prognosis assessment of these patients (2). Based on these two theories, a higher TID ratio may be connected to widespread, "balanced ischemia" brought on by severe CAD (7). From this observational study, the high TID ratio with normal MPI is associated with multivessel disease. It is probable that TID is merely physiologic in many people, emerging as an unexplained variation of normal. Patients with normal MPI but abnormal TID ratios have higher overall event rates (3,4,6). Hence, it would be prudent not to exclude a patient with elevated TID from consideration of coronary angiography. Moreover, increased TID may be helpful in selecting patients at sufficiently increased risk. In these cases, coronary angiography or other noninvasive testing like noninvasive coronary angiography would be appropriate. Considering all other relevant data like usual angina, advanced age, and diabetes, the results also emphasize the value of incorporating TID as a complementary diagnostic marker in myocardial perfusion imaging. Given its ability to predict severe CAD, elevated TID should prompt further investigation, including angiographic evaluation, to assess the extent and severity of coronary involvement. Overall, the study reinforces the importance of TID as a prognostic marker and its association with extensive CAD. The findings suggest that patients with elevated TID values, particularly those with TVD or DVD, warrant aggressive diagnostic and therapeutic strategies to mitigate their risk of adverse cardiac events. Further research with larger cohorts is recommended to validate these observations and refine clinical guidelines for managing patients with elevated TID and normal perfusion scans.

There are several limitations to this study. Data used in the study are exclusive to one nuclear cardiology center and may not be relevant to other nuclear laboratories due to their unique technological features. The statistics reported in this work pertain to the TID ratio generated using the software; more research would be necessary to ascertain whether these results extend to other software programs, even though it has been demonstrated that automated TID

computations using various software approaches are similar. Since the current findings are based on a group that was recommended for nuclear testing, they might not be generalizable to a larger population.

CONCLUSION

In patients with otherwise normal MPI, TID is an independent and incremental prognostic predictor. When TID is present, low-risk prognostic statements should be approached with care, particularly in patients with typical angina, the elderly, and diabetics. In this observational investigation, the occurrence of elevated TID together with otherwise normal SPECT MPI, which indicates the presence of CAD and indicates a considerable risk of cardiac events, highlights the clinical importance of obstructive CAD.

REFERENCES

1. Abidov, A., Bax, J.J., Hayes, S.W., Hachamovitch, R., Cohen, I., Gerlach, J., Kang, X., Friedman, J.D., Germano, G. and Berman, D.S., (2003). 'Transient ischemic dilation ratio of the left ventricle is a significant predictor of future cardiac events in patients with otherwise normal myocardial perfusion SPECT.' *Journal of the American College of Cardiology*, 42(10), pp.1818-1825.
2. Alama, M., Labos, C., Emery, H., Iwanochko, R.M., Freeman, M., Husain, M. and Lee, D.S., (2018). 'Diagnostic and prognostic significance of transient ischemic dilation (TID) in myocardial perfusion imaging: A systematic review and meta-analysis.' *Journal of Nuclear Cardiology*, 25, pp.724-737.
3. Golzar, Y., Olusanya, A., Pe, N., Dua, S.G., Golzar, J., Gidea, C. and Doukky, R., (2015). 'The significance of automatically measured transient ischemic dilation in identifying severe and extensive coronary artery disease in regadenoson, single-isotope technetium-99m myocardial perfusion SPECT.' *Journal of Nuclear Cardiology*, 22, pp.526-534.
4. Katz, J.S., Ruissi, M., Giedd, K.N. and Rachko, M., (2012). 'Assessment of transient ischemic dilation (TID) ratio in gated SPECT myocardial perfusion imaging (MPI) using regadenoson, a new agent for pharmacologic stress testing.' *Journal of Nuclear Cardiology*, 19(4), pp.727-734.
5. Mazzanti, M., Germano, G., Kiat, H., Kavanagh, P.B., Alexanderson, E., Friedman, J.D., Hachamovitch, R., Van Train, K.F. and Berman, D.S., (1996). 'Identification of severe and extensive coronary artery disease by automatic measurement of transient ischemic dilation of the left ventricle in dual-isotope myocardial perfusion SPECT.' *Journal of the American College of Cardiology*, 27(7), pp.1612-1620.
6. Taillefer, R., (2018). 'Transient dilation of the left ventricular cavity observed during myocardial perfusion imaging: What is its incremental diagnostic value.' *Journal of Nuclear Cardiology*, 25(2), pp.593-595.
7. Valdiviezo, C., Motivala, A.A., Hachamovitch, R., Chamrath, M., Navarro, P.C., Ostfeld, R.J., Kim, M. and Travin, M.I., (2011). 'The significance of transient ischemic dilation in the setting of otherwise normal SPECT radionuclide myocardial perfusion images.' *Journal of Nuclear Cardiology*, 18, pp.220-229.