Evaluation of Transient Ischemic Dilation (TID) Ratio in Gated SPECT Myocardial Perfusion Imaging (MPI) with Pharmacological Stress Agents

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ABSTRACT

Objectives: **Transient ischemic dilation (TID) refers to an apparent increase in the size of the left ventricular cavity on stress myocardial perfusion imaging compared to rest imaging. This study was performed to correlate the value of TID ratio in gated SPECT MPI in Coronary Artery Disease (CAD).**

Patients & Methods: **Seventy-four suspected or known CAD patients underwent MPI performed with Tc-99m sestamibi. Single day stress - rest protocol with pharmacological stress was followed, according to established practicing protocol of NINMAS. A statistical analysis was carried out by using the Statistical Package for Social Sciences version 20.0 for Windows (SPSS Inc., Chicago, Illinois, USA). Student t-test was used for continuous variables. Chi-square test used to compare categorical data. P values <0.05 was considered as statistically significant.**

Results: **Among 74 patients, 63(85.1%) were male and 11(14.9%) were female. The mean age found to be 53.8 ± 10.5 years. Majority of (90.5%) patients had hypertension, 45 (60.8%) had diabetes mellitus and 39(52.7%) had dyslipidemia, 44(59.5%) were past smoker. The mean ejection fraction was 44.6 ± 14.6 percent. The mean abnormal TID ratio was 1.25 ± 0.35 in patients having abnormal MPI findings and 1.03 ± 0.21 in having normal MPI findings. The difference was statistically significant (p<0.05) between two groups. Three cases having normal MPI had high TID ratio.Among the patients with TID ratio >1.19, 24 (64.9%) patients were in MVD group and 13 (92.9%) were in SVD group. Whereas, among the patients with TID ratio <1.19, 13 (35.1%) were in MVD group and 1 (7.1%) were in SVD group. The difference was statistically significant (P <0.05) between two groups. The mean TID ratio was 1.08 ± 0.21 in single vessel disease and 1.24 ± 0.26 in multiple vessel disease. The difference was also statistically significant (p <0.05) between two groups.**

Conclusion: **This study suggests that the TID ratios could provide incremental diagnostic information to standard myocardial perfusion analysis for the identification of severe and extensive disease in patients with suspected or known CAD.**

Keywords: **Transient ischemic dilation (TID), Myocardial Perfusion Imaging, Coronary Artery Disease.**

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INTRODUCTION

Cardiac single photon emission computed tomography myocardial perfusion imaging (SPECT MPI) is a useful non-invasive imaging test for evaluation of suspected or known CAD. SPECT MPI offers advantages to clinicians by combining evaluation of myocardial perfusion pattern and functional status of the left ventricle (LV). Additionally, stress-induced ischemic LV dysfunction may be demonstrated by Transient Ischemic Dilation (TID) of LV. TID refers to an apparent increase in the size of the LV cavity on stress myocardial perfusion imaging compared to rest imaging (1).

An interplay of multiple mechanisms is likely responsible for the TID evident on nuclear images, including subendocardial ischemia, temporary systolic dysfunction or myocardial stunning and/or a true increase in LV size. This phenomenon has been observed not only after exercise stress but also in connection with pharmacologic stress testing with the direct coronary vasodilating agents like dipyridamole, dobutamine and adenosine. TID can be measured by dividing the volume of the endocardial surface of the LV cavity on cardiac images obtained at post-stress and rest conditions. Measurement of TID can be performed by commercially available software without additional cost burden and radiation risk for the patients. Currently, TID is recognized as one of the novel indicators of severe/extensive CAD and cardiac events (e.g., non-fatal myocardial infarction and cardiac death), as well as their prognosis (2).

The mean TID ratio in patients with multi-vessel disease is 1.19 (3). Normal TID ratios vary among different publications. Normal values for local population is recommended to be established by each laboratory or country. Combining abnormal TID ratios with abnormal MPI results substantially improves the ability to identify patients with severe and extensive CAD, and they should undergo coronary angiography and possible revascularization. If both are negative, patients have a low probability of severe and extensive CAD and might be candidates for medical management without coronary angiography. Patients who either one positive have an intermediate likelihood of severe and extensive CAD and additional information is probably needed to make a diagnosis. A finding of TID on stress MPI is valuable because it enables clinicians to identify patients with multi vessel CAD despite of otherwise normal MPI results.

PATIENTS AND METHODS

Seventy-four patients with CAD referred to NINMAS for stress MPI by pharmacological agents at various stages of clinical workup constituted the study population. All patients underwent MPI performed with Tc-99m sestamibi. Single day stress - rest protocol was followed, according to the established practicing protocol of NINMAS.SPECT acquisition with ECG gating at rest phase was done 45-60 minutes after rest injection of 16-20 mCi (711 MBq) tracer on the same day following the post-stress scan (done 15-30 minutes after stress injection of 8-10 mCi (370Mbq) of tracer). Acquisition of SPECT images were done with the double-headed SPECT scintillation camera (SIEMENS E.CAM Dual Head and Symbia Evo Excel dual head Gamma Camera) with detectors placed 76° to each other. Low energy all purpose (LEAP) collimators with parallel holes were used with 1.45 zoom. A symmetric 15% energy window around the 140 KeV Tc99m photo-peak was set. Data was stored in 64x64 matrix (pixel size 6.59cmm, 21-27 slices in short axis). ECG gating was done with three limb leads and acquisition was set to eight frames per R-R interval (about 153ms/frame). Rotation of camera heads was set to counter clock wise with starting angle at 52°. The detectors took 32 views over 104° of rotation in a non-circular orbit using a step-and-shoot method, progressing from 45° right anterior oblique to 45° left posterior oblique projections. During acquisition the patient was in supine position with "head out" orientation. Acquisition time was 20 seconds per projection (about 450-750 k counts/detector/view) requiring about 14 minutes per patient per scan. Butterworth filtering with cutoff of 0.5 cycles/sec and order 7 was used.

Out of the total 74 patients 55 already had coronary angiogram (CAG), and their reports were assessed and correlated with MPI and TID findings.

For quantitative assessment of LVEF, TID, EDV,ESV, 4D-MSPECT v4.2 software (Invia LLC, 2007) provided by Siemens medical solutions, Inc. and Toshiba Corporation was applied to process and interpret raw GSMPI images. Perfusion data, measurements of LV volumes, LVEF and LV wall motion were obtained from GSMPI images. A statistical analysis was carried out by using the Statistical Package for Social Sciences version 20.0 for Windows (SPSS Inc., Chicago, Illinois, USA). Student t-test was used for continuous variables. Chi-square test used to compare categorical data. P values <0.05 was considered as statistically significant.

RESULTS

Among the total 74 patients, 85.1% were male. The mean age was found to be 53.8±10.5 years and 63(85.1%) patients were male and 11(14.9%) female. Majority (90.5%) of patients had hypertension, 45(60.8%) had diabetes mellitus and 39(52.7%) had dyslipidaemia, 44(59.5%) were past smoker. The mean ejection fraction was 44.6±14.6 percent.

Almost two third (62.2%) patients had left ventricular hypertrophy and 56(75.7%) had an abnormal ventricular wall motion, 46(62.2%) had H/O MI on echo-cardiogram. In Coronary angiogram 14(18.9%) patients had single vessel disease and 37(50.0%) had multi vessel disease. About (71.6%) patients had abnormal MPI findings and 51(68.9%) patients had gone through adenosine MPI protocol.

The mean abnormal TID ratio was 1.25 ± 0.35abnormal MPI findings and 1.03 ± 0.21 in normal MPI findings. The difference was statistically significant (p <0.05) between two groups. A positive significant correlation (r = 0.297; p = 0.012) observed between TID ratio with MPI findings (Figure-1). MPI at normal findings, 2(14.3%) were in SVD group and 7(18.9%) were in MVD group. Among the patients having abnormal MPI findings, 85.7% were in SVD group and 81.1% were in MVD group. TID ratio at >1.19, 24(64.9%) patients were in MVD group and 13(92.9%) were in SVD group. At <1.19, 13(35.1%) were in MVD group and 1(7.1%) were in SVD group. The difference was statistically significant (P <0.05) between two groups. The mean TID ratio was 1.08 ± 0.21 in single vessel disease and 1.24 ± 0.26 in multiple vessel disease. The difference was statistically significant (p <0.05) between two groups.There was a positive not significant Spearman's correlation between TID ratio and coronary angiogram, where r = 0.217 and p = 0.126 (Figure 2).

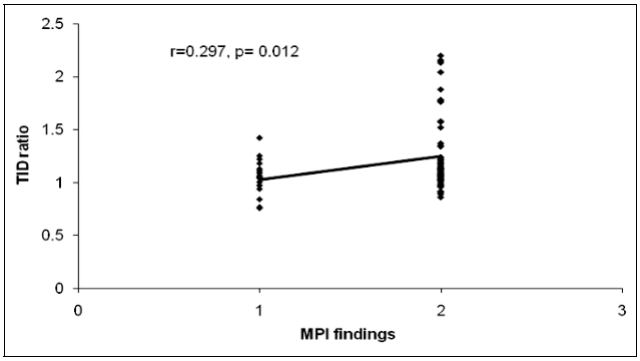

Figure 1: Scatter diagram shows significant positive correlation (r = 0.297; p = 0.012) between TID ratio and MPI findings

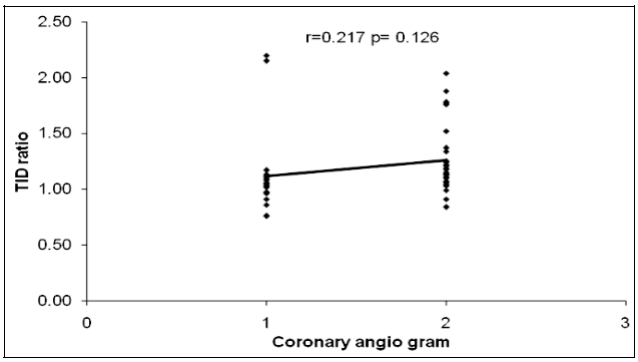

Figure 2: Scatter diagram shows positive not significant correlation (r = 0.217; p = 0.126) between TID ratio and coronary angiogram

DISCUSSION

It was observed in the present study, that more than one third (39.2%) of the patients belonged to age 51-60 years. The mean age was found 53.8±10.5 years with range from 33 to 81 years. Aldhilan et al. found the mean age of 66.7±11.1 years ranging from 43 to 85 years (4), which is higher than the current study. Katz et al. also found higher mean age in his study the mean age was found 67.1±11.1 years (3), which is also higher than the current study. The higher trend of age due to geographical variations, racial, ethnic might differences, genetic causes, different lifestyle, and increased life expectancy may have significant influence to develop CAD in older age. It was observed that 85.1% patients were male and 14.9% female and male female ratio was 5.7:1, which indicates that CAD is predominant in male subjects.

In the present study, the mean TID ratio was found 1.25 ± 0.35 ranging from 0.86 to 2.20 in patients having abnormal MPI findings and 1.03 ± 0.21 ranging from 0.76 to 1.42 in patients having normal MPI findings. The mean TID ratio was significantly (p <0.05) higher in patients having abnormal MPI findings. Choi et al. and Hida et al.reported that the TID ratio strongly correlated with the extent and severity of stress-induced perfusion abnormality; thus higher TID ratios propose a greater ischemic burden (5,6). Similarly, this study showed positive significant correlation (r = 0.297; p = 0.012) between TID ratio with MPI findings (Fig 1). TID has been shown to correlate with the presence of multi-vessel disease and indicates adverse outcomes, even in the absence of significant perfusion defects (7,8).

The study shows that among the patients having normal MPI findings, 14.3% were in SVD group and 18.9% were in MVD group as reported on coronary angiography. In patients having TID ratio >1.19, it was observed that 64.9% patients were in MVD group and 92.9% were in SVD group. Whereas, in patients having TID ratio <1.19, 35.1% were in MVD group and 7.1% were in SVD group. The difference was statistically significant (P<0.05) between two groups. It was also observed that the mean TID ratio was

1.08±0.21 ranging from 0.76 to 2.15 in single vessel disease and 1.24 ± 0.26 with range from 0.81 to 2.20 in multi vessel disease. The difference was statistically significant ($p<0.05$) between two groups. Katz et al., found the mean TID ratio for non-obstructive disease 1.09 ± 0.16, single vessel disease 1.15 ± 0.19 and multi vessel disease 1.19 ± 0.26 (3). Their study shows a significant relationship between the TID and the degree of CAD. Patients with three vessel disease had significantly higher TID than those without severe disease. Kakhki et al. mentioned in their study that a high TID is purported to indicate severity of CAD and multi-vessel disease (9). There was a positive not significant Spearman's correlation between TID ratio and coronary angiogram, where $r = 0.217$ and $p = 0.126$ (Fig 2).

Normal ranges of the TID varies among populations and depend upon the gender, type of stress, injection and imaging protocols, and radiopharmaceuticals employed (10). Combining abnormal TID ratios with abnormal MPI results substantially improves the ability to identify patients with severe and extensive CAD, and they should be for coronary angiography and possible revascularization (11). In general, the TID ratio is higher in MVD or in severe CAD. Usually MPI and TID ratio are parallel but in certain cases exception were noted. It was observed that in three cases with normal MPI findings had high TID ratio. On clinical findings they have classical risk factors (hypertension and diabetes mellitus and hypothyroidism). A finding of TID on stress MPI is valuable in such situations because it enables clinicians to predict patients with multi vessel CAD despite otherwise normal MPI results. These patients need further follow-up.

CONCLUSION

This study suggests that the TID ratios could provide incremental diagnostic information to standard myocardial perfusion analysis for the identification of severe and extensive disease in patients with suspected or known CAD.This is especially useful in patients having normal perfusion with higher TID ratio as in the case of balanced ischemia.

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