# Attenuation correction reveals gender-related differences in the normal values of transient ischemic dilation index in rest-exercise stress sestamibi myocardial perfusion imaging

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***Background.*** **Transient ischemic dilation (TID) has been established as an important independent marker of severe and extensive coronary artery disease (CAD) in myocardial perfusion imaging (MPI). The accuracy of the TID index is dependent on a well-determined threshold (normal limits) between normal and abnormal values for each study protocol. To date, the effects of neither gender nor attenuation correction (AC) on TID normal limits have been established. Thus, the objectives of this study were to determine if AC processing changes the normal value of the TID index and if there were gender-related differences in the TID index of normal patients who had undergone rest/exercise-stress technetium-99m sestamibi MPI.**

***Methods and Results.*** **Seventy-five patients (33 women, 42 men; mean age, 57.7 ± 11.7 y and 55.9 ± 10.0 y, respectively) with less than a 5% likelihood of CAD, who had undergone low-dose rest/high-dose exercise-stress Tc-99m sestamibi MPI, were studied. All studies were acquired using simultaneous emission/transmission scans and were corrected for attenuation, scatter, and resolution effects using the ExSPECT II method. Both the AC and non-AC studies were analyzed using the Emory Cardiac Toolbox (ECTb; Syntermed, Inc, Atlanta, Ga) quantitative software. The TID index was calculated automatically as the ratio of stress mean left ventricular volumes to rest mean left ventricular volumes by ECTb. Patients were grouped by gender and the TID indices from AC and non-AC studies were compared. Linear regressions of the TID index and body mass index were analyzed to exclude differences in body size between male and female patients as a confounding factor in gender-related differences in TID. The TID index upper normal limits were calculated as the mean value plus 2 standard deviations (SDs). AC processing did not change the TID index significantly whether the genders were combined or separated (AC TID = 0.97 ± 0.14 vs non-AC TID = 0.98 ± 0.12 for all patients). Female patients showed higher mean TID indices than male patients in both AC (1.01 ± 0.15 vs 0.95 ± 0.12) and non-AC studies (1.00 ± 0.15 vs. 0.97 ± 0.10), but this difference was statistically significant only in AC studies ($p = .03$). TID indices remained constant across the range of body mass index studied. The TID index upper normal limit was 1.31 for female and 1.18 for male patients.**

***Conclusion.*** **TID normal values for rest/exercise-stress Tc-99m sestamibi MPI are gender-dependent and not affected by AC processing. Thus, diagnosticians should take into account these gender-related differences, as compared with the traditional value generated from mostly**

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**male populations, to ensure both men and women have the same overall accuracy of using the TID index in the diagnosis and prognosis of CAD. (J Nucl Cardiol 2006;13:338-44.)**

**Key Words: Transient ischemic dilation • normal values • attenuation correction**

Myocardial perfusion imaging (MPI) has been established as an important noninvasive tool in the assessment of coronary artery disease (CAD) during the past 2 decades[1] and continues to grow at an unprecedented rate in the United States. This growth has been warranted because of the excellent accuracy of MPI for detecting the presence of CAD. One reason for its success has been the establishment of quantitative analysis, which depends on well-characterized normal databases. MPI diagnostic accuracy also has been improved by taking into account gender-related differences of uncorrected perfusion normal distribution[2] and of left ventricular ejection fraction.[3] More recently, attenuation correction (AC) MPI studies have become more widespread and the superiority of attenuation-corrected normal databases over uncorrected ones has been established.[4]

Despite the success of MPI, detection of multivessel disease still is limited particularly when there is balanced reduction of flow yielding a homogeneous tracer distribution. In these patients detection of multivessel disease has required the use of other markers of CAD.[5] Multiple studies have shown that transient ischemic dilation (TID) clearly is associated with severe and extensive CAD and consequently it has been established as an important independent marker for detecting multivessel disease in a variety of study protocols.[6-12] The accuracy of TID is dependent on its normal limit value, which already has been shown to be protocol-dependent.[7-10]

The implementation of new AC methods (ExSPECT II [Philips Laboratories, Malpitas, Calif]) that use iterative reconstruction algorithms and correct the images for attenuation, scatter, and resolution effects, has proven to increase the diagnostic value of MPI.[4] Also, the normal values of TID indices determined to date have not addressed gender differences, and some of the previous study populations have been weighted heavily with male patients.[7-12]

Thus, the objectives of this study were to determine the possible effects of AC processing and of gender on the TID indices of normal patients who have undergone rest/exercise-stress technetium-99m myocardial perfusion imaging.

## MATERIALS AND METHODS

Seventy-five patients were studied. There were 33 women (mean age, 57.7 ± 11.7 y; body mass index [BMI], 33.5 ± 12.6 kg/m$^2$) and 42 men (mean age, 55.9 ± 10.0 y; BMI, 30.4 ± 6.90 kg/m$^2$). BMI was not calculated in 2 female and 4 male patients owing to either the height or weight information not being available. All patients had less than a 5% likelihood of coronary artery disease (CAD) based on sequential Bayesian analysis of age, gender, symptom classification, and results of exercise electrocardiography.[13] All patients had undergone low-dose rest/high-dose exercise-stress Tc-99m sestamibi MPI. The studies were obtained from 2 institutions: 46 from Cardiovascular Consultants (Kansas City, Mo) and 29 from Emory University Hospital (Atlanta, Ga).

### Image Procedure

All data were acquired using simultaneous emission/transmission scans and corrected for attenuation, scatter, and resolution effects using the ExSPECT II method.[14-18] For reasons of brevity we will refer to this comprehensive technique as AC. Briefly, all patients were studied by the use of a previously reported simultaneous emission/transmission acquisition method that uses a scanning gadolinium-153 line source as the transmission source.[4] The protocol involved a same-day rest-stress Tc-99m sestamibi (Bristol-Myers Squibb Medical Imaging, Billerica, Mass) imaging approach. The Tc-99m sestamibi doses, adjusted for body weight, were 9 to 15 mCi for rest and 22 to 45 mCi for stress. A stress injection of Tc-99m sestamibi was administered during peak exercise via a Bruce treadmill protocol.

**Acquisition protocol.** Images were acquired with a low-energy high-resolution collimator, by use of a 180° noncircular orbit from 45° right anterior oblique to left posterior oblique, with a 64 × 64 matrix (pixel size, ≈0.64 cm) for the emission images and a 128 × 128 matrix (pixel size, 0.32 cm) for the transmission images. The data were collected in 3 individual photopeaks: (1) emission, 140 keV ± 10%; (2) transmission, 100 keV ± 10%; and (3) scatter, 118 keV ± 6%. A total of 64 simultaneous emission, transmission, and scatter projections were obtained (usually 25-30 s/projection).

### Computer Processing and Analysis

**Tomographic reconstruction.** Each of the projection images were corrected for nonuniformity with a flood source image containing 30 million counts, and the mechanical center of rotation was determined to align the projection data with respect to the reconstruction matrix. The projection images from the rest and stress studies then were corrected automatically for radioactive decay occurring during acquisition. For comparison purposes, emission images were reconstructed with and without attenuation correction. The non-AC myocardial perfusion transverse images were reconstructed by use of standard filtered backprojection after low-pass filtering for noise. The stress and rest studies were reconstructed using a Butterworth filter with a critical frequency of 0.46 Nyquist with an order of 5.0 and a critical frequency of 0.32 Nyquist with an