A Thallium-201 SPECT Artifact Associated with Leg Flexion: Case Report

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We present a case of a thallium-201 (^{201}Tl) SPECT artifact created similarly to those associated with post-exercise "upward-creep," yet alternatively related to the flexion of a patient's legs during data acquisition.

CASE REPORT

A 57-yr-old white female with a three-month history of left arm pain and abnormal routine exercise stress test was referred to our laboratory for an exercise ^{201}Tl study. Using a standard Bruce protocol, the patient exercised for 8 min 20 sec without experiencing any chest pain or left arm discomfort. Exercise was terminated because of leg fatigue. Resting heart rate was 68 with a blood pressure of 150/77. The maximum achieved heart rate and blood pressure during exercise were 160 and 227/106, respectively. The electrocardiogram showed a normal sinus rhythm and probable left ventricular hypertrophy by voltage with 0.5 to 1.5 mm upsloping to flat ST segment depression in leads II, III, AVF, V5, and V6 during exercise and early recovery.

At peak exercise, 3.5 mCi of ^{201}Tl was administered intravenously. The patient was positioned supine on the imaging table with the legs fully extended. An initial 5-min anterior planar image was performed followed immediately by SPECT imaging using a 180° arc (32 increments, 40 sec, 64 × 64 matrix) beginning in a right anterior oblique position and ending in a left posterior oblique position (*1,2*). During the period of data acquisition, the patient voluntarily flexed her legs to relieve tension on the lower back. From visual inspection of the rotating raw planar images along with a sinogram generation, movement of the myocardium in the vertical direction was identified at the approximate time point when the patient flexed her legs. Vertical and horizontal long- and short-axis oblique slices were generated using a standardized image reconstruction algorithm in our laboratory (a 1-2-1 Y Filter followed by a Butterworth filter of order 5 and 0.5 cutoff frequency). The severity of this motion upon image quality was demonstrated by the presence of a "tuning fork" artifact in the inferoseptal segment of the myocardium (Fig. 1A). Since we had seen this previously unexplained phenomena in a few patients and after ruling out the potential influence of poor SPECT quality control in this case, our suspicion was raised that perhaps leg flexion might be the associated influence. Redistribution imaging 3 hr post-exercise was performed with the legs fully extended throughout the data acquisition.

With the patient's verbal consent, a second acquisition was repeated in identical fashion post-exercise with leg flexion initiated at the midpoint of the data acquisition sequence and maintained throughout the study. It is important to note that movement of the shoulder girdle did not occur with leg flexion and hence was noncontributory. Also, the visual interpretation of the planar and rotating SPECT images revealed no transient or fixed myocardial perfusion defect leading us to further believe that the artifact was created by the leg flexion.

Image processing was performed in the same manner as the immediate post-exercise study. Visual inspection of the rotating planar images, sinogram and reconstructed slices from the first redistribution study did not demonstrate any vertical movement of the myocardium and the perfusion pattern was unequivocally normal (Fig. 1B), whereas leg flexion during the second study mimicked the same "tuning fork" artifact as the immediate post-exercise study. (Fig. 1C).

DISCUSSION

Distortions in image reconstruction as a result of changes in heart position leading to false-positive defects in ^{201}Tl SPECT has been documented and termed by other investigators as "upward creep." This phenomena has only been demonstrated in immediate post-exercise data acquisition when the heart gradually moves within the chest. This has been postulated to occur as a result of increase in mean total lung volume with a consequent depression of the diaphragm which subsequently lowers the position of the heart. It is only after the mean lung volume diminishes that the diaphragm and heart assume a normal baseline position (*3*). Left hemidiaphragmatic elevation or eventration, particularly in circumstances of tracer avid visceral activity, may also likely superimpose the inferior left ventricular myocardial wall resulting in an increase in count density in the myocardial segments directly underlying the visceral activity (*4*). Al-

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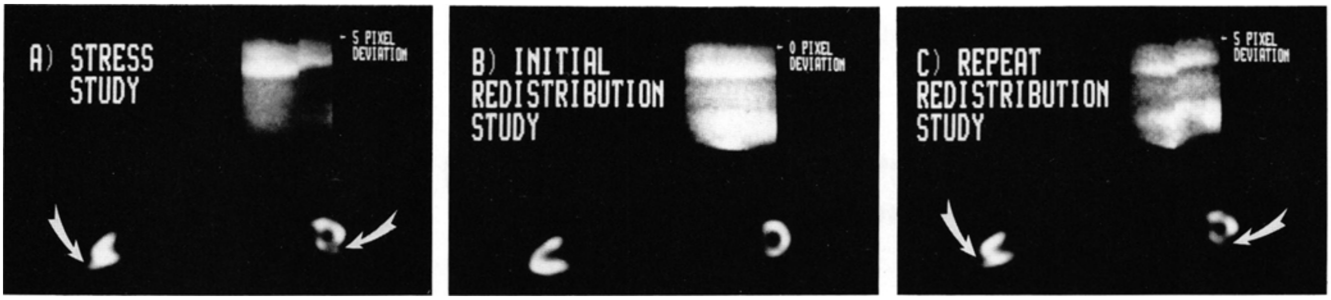

FIG 1. (A) Vertical and short-axis slices with corresponding sinogram demonstrating myocardial movement as a result of leg flexion with "tuning fork" artifact in stress study. (B) Initial redistribution study with constant leg extension demonstrates no artifact, (C) yet it is replicated in second redistribution study when flexion is repeated.

though it has been reported that patient motion as little as 3 mm (0.5 pixel) can create distortions in ^{201}Tl SPECT images, DuPuey and Garcia state that slight patient motion is tolerable and does not produce significant artifacts; however, the severity of image artifacts depends upon the direction and magnitude of the patient motion, the planar frames where it occurs, and whether the heart returns to its baseline position (*4*).

It is our contention that the excursion of the diaphragm due to the upward and downward shift in abdominal viscera occurs during flexion and extension of the lower legs. During ^{201}Tl SPECT data acquisition this change in leg position creates inferoseptal myocardial perfusion defects similarly found in "upward creep" of the myocardium. Although we have only reported this finding in a single patient, we have previously seen this phenomena in patients undergoing ^{201}Tl SPECT who wish to minimize lumbar back discomfort by flexing their legs (which deaccentuates lumbar lordosis). This mechanical "upward creep" may be potentially more critical in producing image artifacts since this diaphragmatic motion abruptly causes severe unidirectional motion (greater than 0.5 pixel) over multiple planar images.

Previous attention has focused upon the importance of arm positioning and maintaining comfort during ^{201}Tl SPECT imaging in order to reduce motion (*1,2,4*). We believe it is now apparent that maintaining constant leg positioning is of equal importance. Therefore, it is imperative that the technologist reminds the patient that the legs must remain either fully extended or slightly flexed (supported by a cushion under the knees) during ^{201}Tl SPECT data acquisition.

Assurance that the highest quality diagnostic images have been obtained should be routinely assessed by visual inspection of the rotating planar images or sinogram. Of utmost importance is thoughtful positioning and thorough technologist-patient communication. We believe, however, that further investigation of the extent of the effect of leg flexion based upon either gender and/or chest circumference may be warranted to fully understand this phenomena.

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