Shifting breast attenuation artifact mimicking ischemia: Resolved with attenuation correction

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BACKGROUND

Breast attenuation commonly results in myocardial perfusion SPECT artifacts.[1,2] The location of the artifact depends upon the position of the overlying left breast during SPECT acquisition. Anterior and lateral artifacts are common, but even inferior artifacts may occur in women with pendulous breasts. If breast position is constant in the rest and post-stress SPECT acquisitions, a fixed defect will occur. If regional wall motion is normal, it can be safely assumed that the fixed defect is attributable to a breast attenuation artifact. However, if the breast differs in position (i.e., shifts) between the rest and post-stress acquisitions, a variable attenuation artifact results, which may mimic stress-induced ischemia. Because post-stress-gated imaging evaluates wall motion at rest, usually 30 to 40 minutes after the stress radiopharmaceutical injection, assessment of regional wall motion is not helpful to differentiate stress-induced ischemia (with a resulting only transient wall motion abnormality, resolved at the time of the post-stress SPECT acquisition) from a shifting breast attenuation artifact.

Attenuation correction is an effective means to eliminate soft tissue attenuation artifacts and increase test specificity. Both fixed attenuation artifacts as well as those that vary between the rest and post-stress acquisitions can be resolved.

The following case example demonstrates the value of low-dose X-ray attenuation correction in resolving a shifting breast attenuation artifact.

CASE EXAMPLE

This 59 year old with hypercholesterolemia and hypertension presented with exertional dyspnea and fatigue and atypical chest pain. A single-day Tc-99m sestamibi 9.2 mCi rest/31.3 mCi regadenoson pharmacologic SPECT scan was performed. Low-dose X-ray CT attenuation correction was applied to the stress and rest images.

The patient noted no chest pain, and there were no electrocardiographic abnormalities during pharmacologic stress

Close inspection of the planar projection images (Figure 1) reveals that the position of the left breast varies between the rest (right) and post-stress (left) left anterior oblique projections. In the resting image, the breast shadow is noted to lie over the entire left ventricle, whereas in the post-stress image it overlies only the upper 1/2 to 2/3 of the ventricle. The unattenuated inferior wall is relatively bright. Of note, evaluation of low count density planar projection images is difficult form static images such as these. However, when the planar projection images are displayed in endless loop cinematic format, evaluation of attenuators is facilitated.

In the reconstructed tomograms (Figure 1), an extensive mildly to moderately severe reversible anterior/anterolateral defect is present. This is also clearly demonstrated in reconstructed polar plots (Figure 2).

Attenuation-corrected tomograms (Figure 3) demonstrate homogenous tracer distribution throughout the myocardium and complete resolution of the post-stress reversible anterior defect. The corresponding polar plots (Figure 4) are likewise normal.

DISCUSSION

This case example demonstrates the value of low-dose X-ray attenuation correction in resolving a shifting breast attenuation artifact. Awareness of this artifact on

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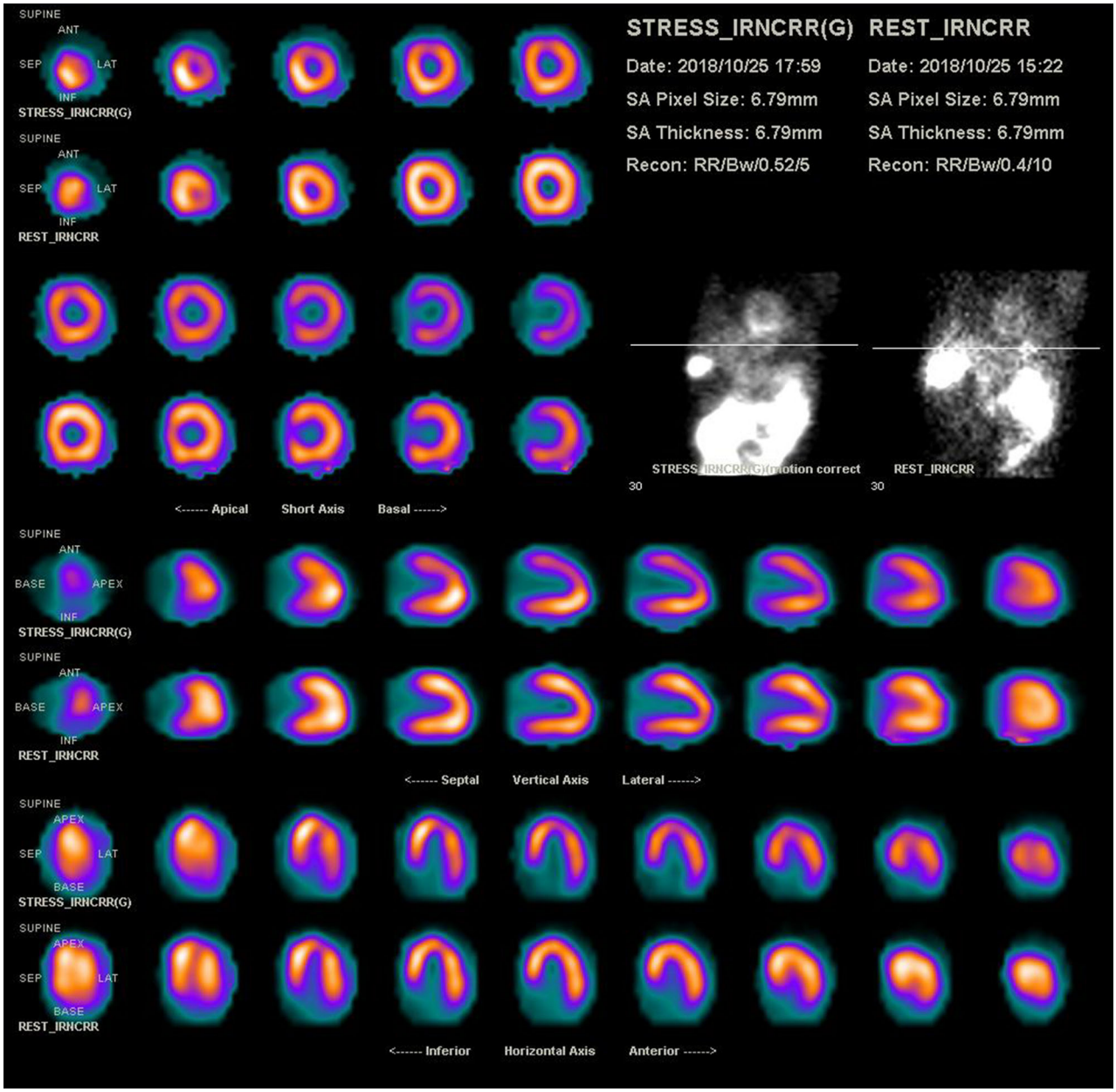

Figure 1. In planar projection images, the position of the left breast is noted to vary between the rest (right) and post-stress (left) left anterior oblique projections. In the resting image, the breast shadow is noted to lie over the entire left ventricle, whereas in the post-stress image it overlies only the upper 1/2 to 2/3 of the ventricle. The unattenuated inferior wall is relatively bright. In the reconstructed tomograms, an extensive mildly to moderately severe reversible anterior/anterolateral defect is present.

the part of both the nuclear cardiology technologists and interpreting physicians is key to its recognition and avoidance.

For the technologist consistent patient positioning for the rest and post-stress SPECT acquisitions is critical. Ideally for myocardial perfusion SPECT, the patient's arms should be elevated above the head (Figure 5A) to allow close approximation of the detector heads to the chest wall. In this position, the breasts are elevated high on the anterior chest wall. However, some patients, particularly those with shoulder pain, cannot fully elevate the arms. For them a less fully extended arm position (Figure 5B) may be used, although the camera head-to-chest wall distance will be greater and

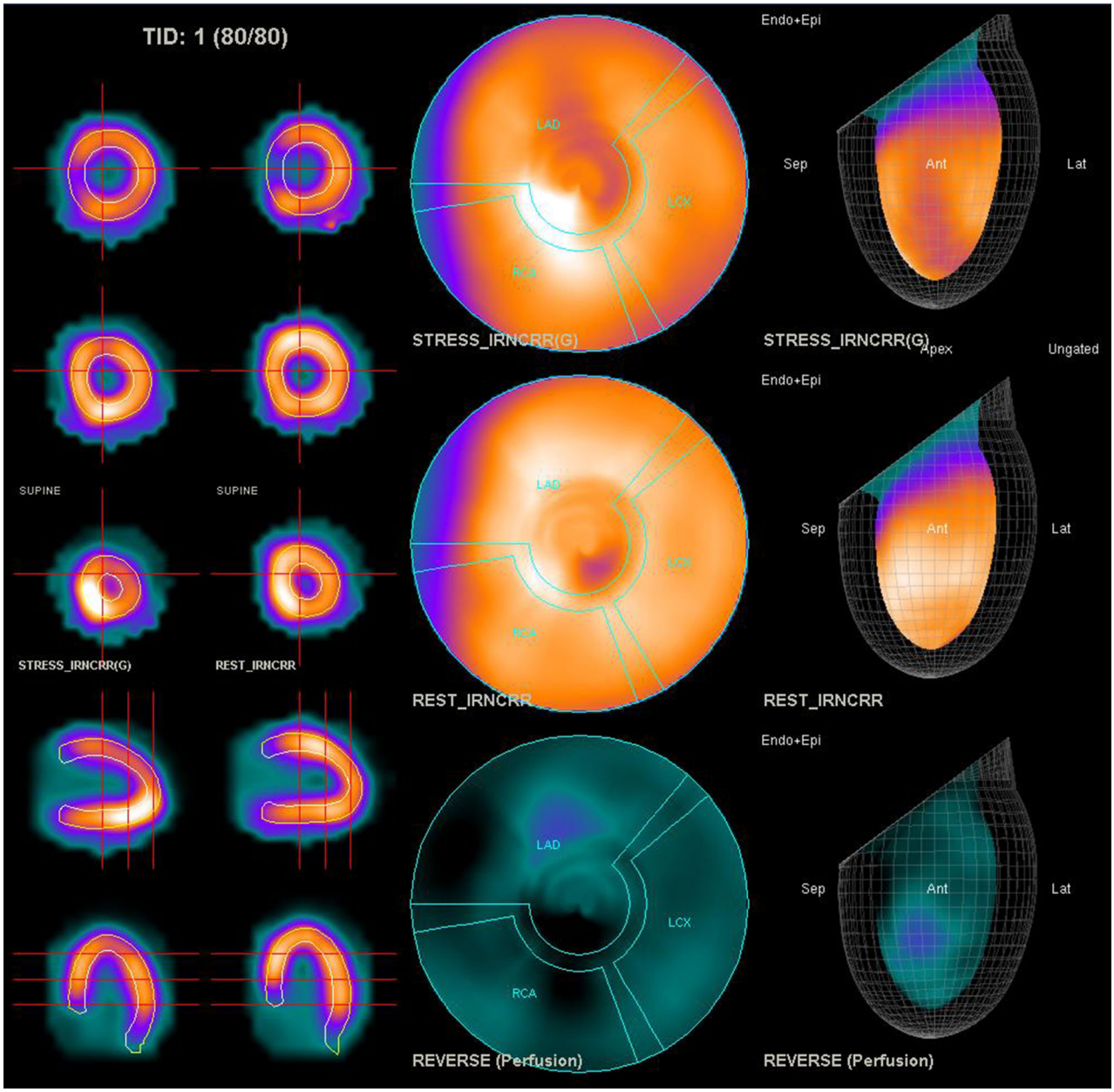

Figure 2. Polar plots reconstructed from the tomograms in Fig. 1 similarly reveal and apparent extensive mildly to moderately severe reversible anterior/anterolateral defect.

the resulting image resolution may be poorer. In this position, the breasts lie lower on the chest wall. Whichever arm position is used, it is most important that it is identical for both the rest and post-stress SPECT acquisitions. With variation in arm positions between the rest and post-stress SPECT acquisition, the position of the left breast may shift, resulting in a shifting breast attenuation artifact.

For the interpreting physician a stepwise systematic approach to SPECT scan, interpretation is essential to confidently attribute a reversible anterior perfusion defect to shifting breast position. Close inspection of planar projection images is essential to assess breast position and to determine whether the left breast has shifted in position between the rest and post-stress SPECT acquisitions. In our experience, display of the planar projection images in endless loop cinematic format in a linear black and white scale is preferable. When there is significant breast attenuation, a curvilinear ''shadow'' is apparent corresponding to the inferior/

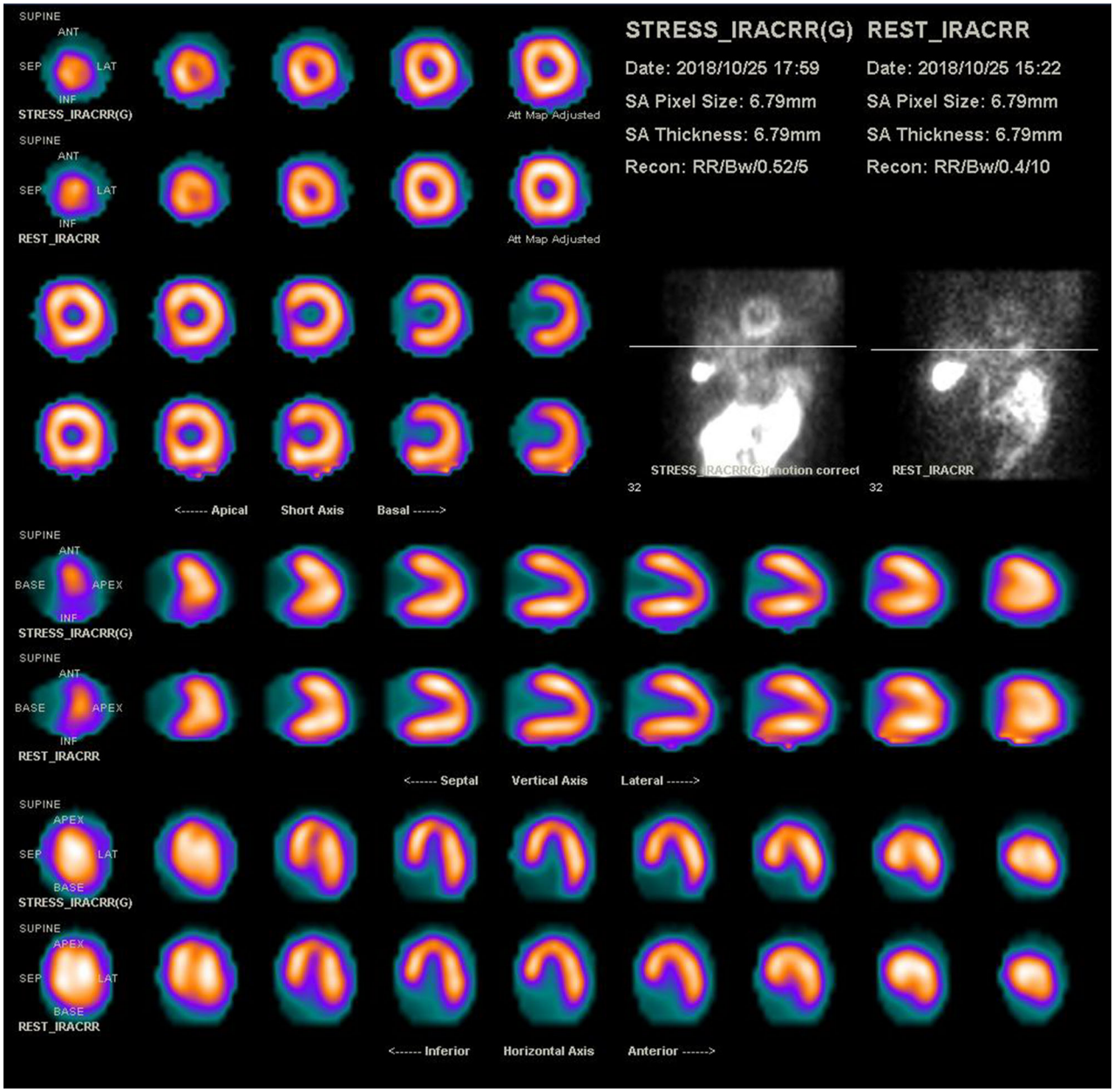

Figure 3. In low-dose X-ray attenuation-corrected images, the apparent post-stress anterior/anterolateral perfusion defect is completely resolved.

inferoposterior border of the breast (Figure 1). After close inspection of the planar projection images, tomograms, polar plots, and gated images should be interpreted.

Attenuation-corrected images should be viewed only after inspection of the non-attenuation-corrected tomograms. Attenuation correction itself may introduce artifacts. In particular, subdiaphragmatic scatter into the inferior wall of the left ventricle may be exaggerated with attenuation correction. If tomograms are then normalized to the ''hot'' inferior wall, an artifactual anterior defect may occur. Therefore, attenuation correction for breast artifacts may be helpful only in patients without excessive subdiaphragmatic tracer concentration.

In conclusion, a coordinated effort by the technologist and interpreting physician and awareness of the potential for shifting breast attenuation artifact is key to its avoidance and recognition. Attenuation correction is

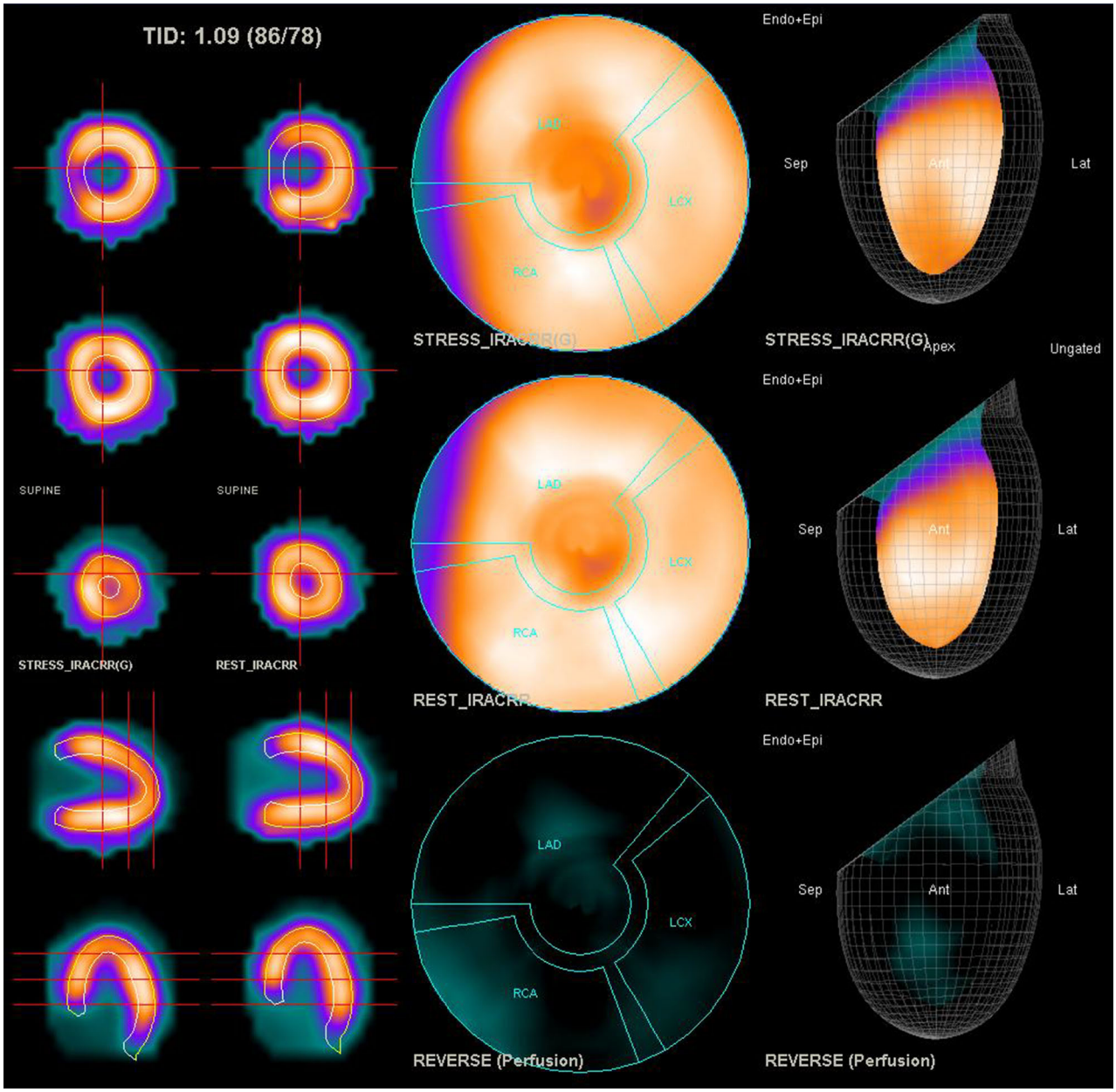

Figure 4. Polar plots reconstructed from the tomograms in Fig. 3 are normal.

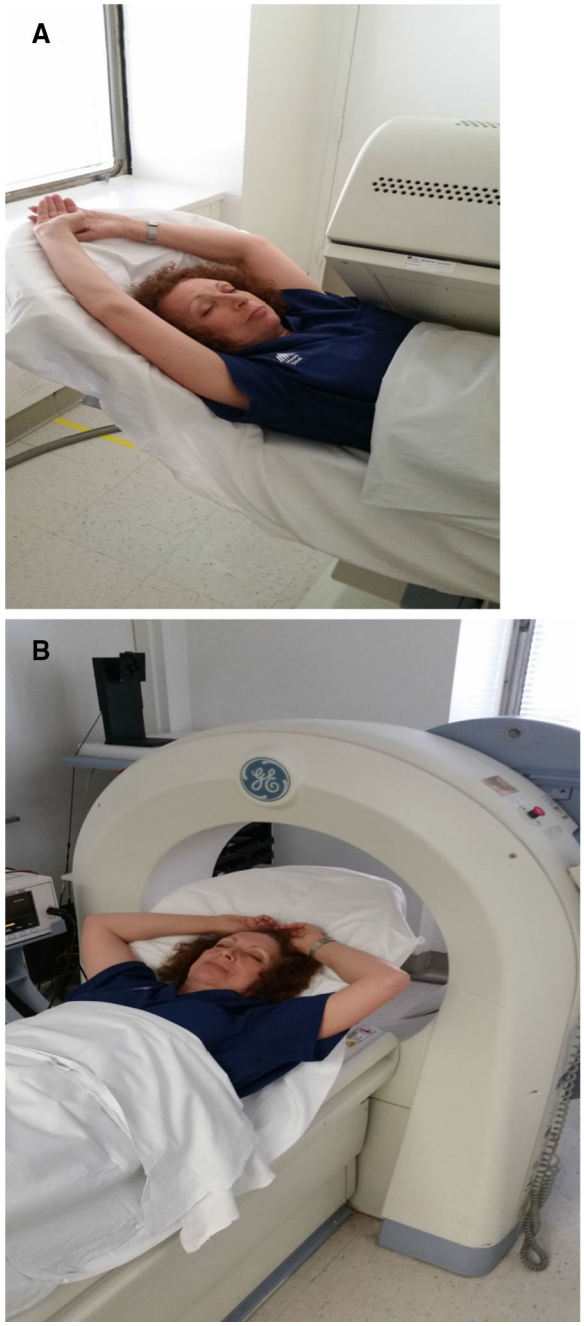

Figure 5. **A** Patient positioned with the arms extended above the head. This position will elevate the breasts over the chest wall. **B** Patient positioned with the arms less fully extended. This position will allow the breast to move lower on the chest wall.

a valuable tool in resolving the artifact and improving test specificity.

Disclosure

None of the authors have significant relationships to disclose.

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