

# Ramp filter artifact associated with filtered backprojection, resolved with iterative reconstruction

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## BACKGROUND

The Ramp filter is routinely employed when myocardial perfusion SPECT images are processed using filtered backprojection. It eliminates the star artifact resulting from superimposition of backprojections from multiple angle acquisitions. Back-projected data are weighted linearly as a function of frequency in the frequency domain.<sup>1-4</sup> The Ramp filter operates only in the  $x$ -plane. By this means it eliminates activity adjacent to an intense object in the  $x$ -plane, better defining its borders and increasing contrast and spatial resolution. Myocardial perfusion tomograms are thereby rendered sharper with better definition of the endocardial borders.<sup>5</sup>

However, when the Ramp filter is applied to an intense subdiaphragmatic structure such as the stomach, gallbladder, or bowel that lies in the  $x$ -plane of the heart, it may subtract counts from the inferior wall of the left

ventricle, resulting in a photopenic artifact that may mimic a true perfusion abnormality.

Iterative reconstruction, specifically ordered subset expectation maximization (OSEM), currently implemented on all commercially available cardiac SPECT cameras, does not employ the Ramp filter, but instead minimizes image noise and sharpens the myocardial borders by means of a series of iterations comparing the acquired backprojected image to an expected image. In the recently published revised Myocardial Perfusion SPECT Guidelines iterative reconstruction is recommended for image processing in preference to filtered backprojection.<sup>6</sup>

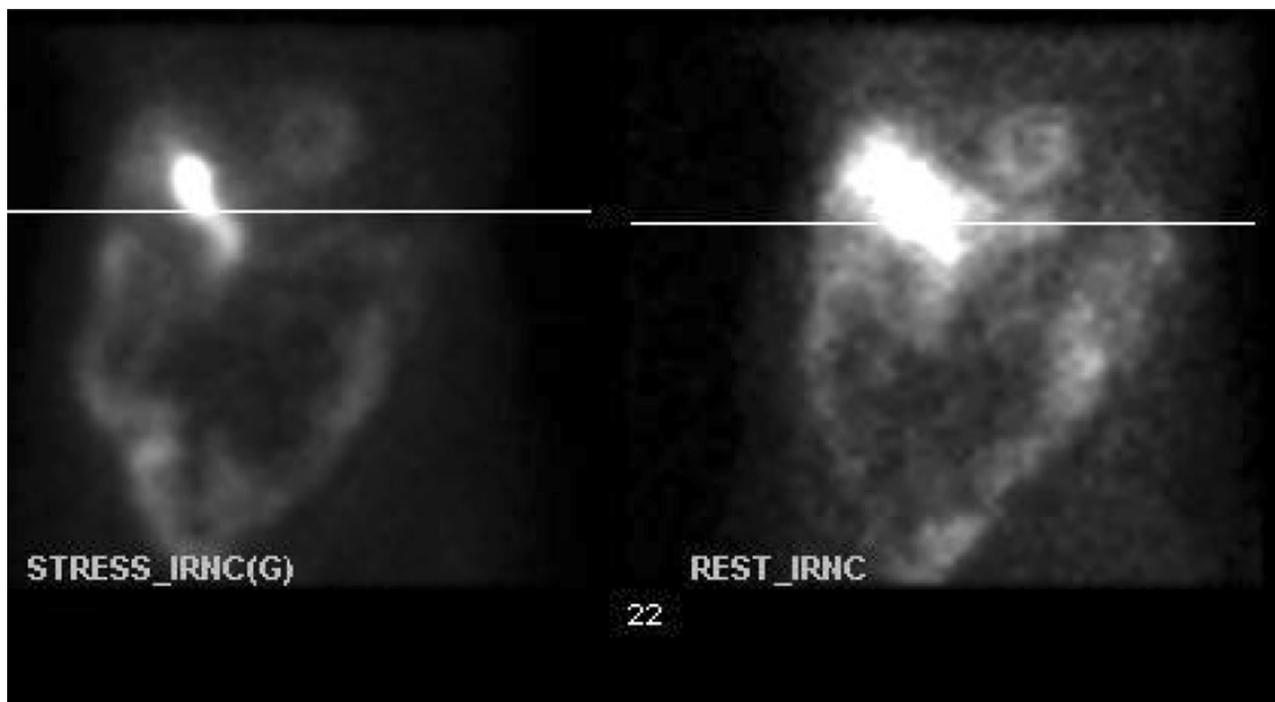
## CASE EXAMPLE

A 78-year-old woman with non-cardiac chest pain and exertional dyspnea was referred for a pharmacologic stress myocardial perfusion scan. She had no prior

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**Figure 1.** Post-pharmacologic stress (left) and resting (right) anterior planar projection images demonstrate intense radiotracer concentration in the hepatic and common bile duct.

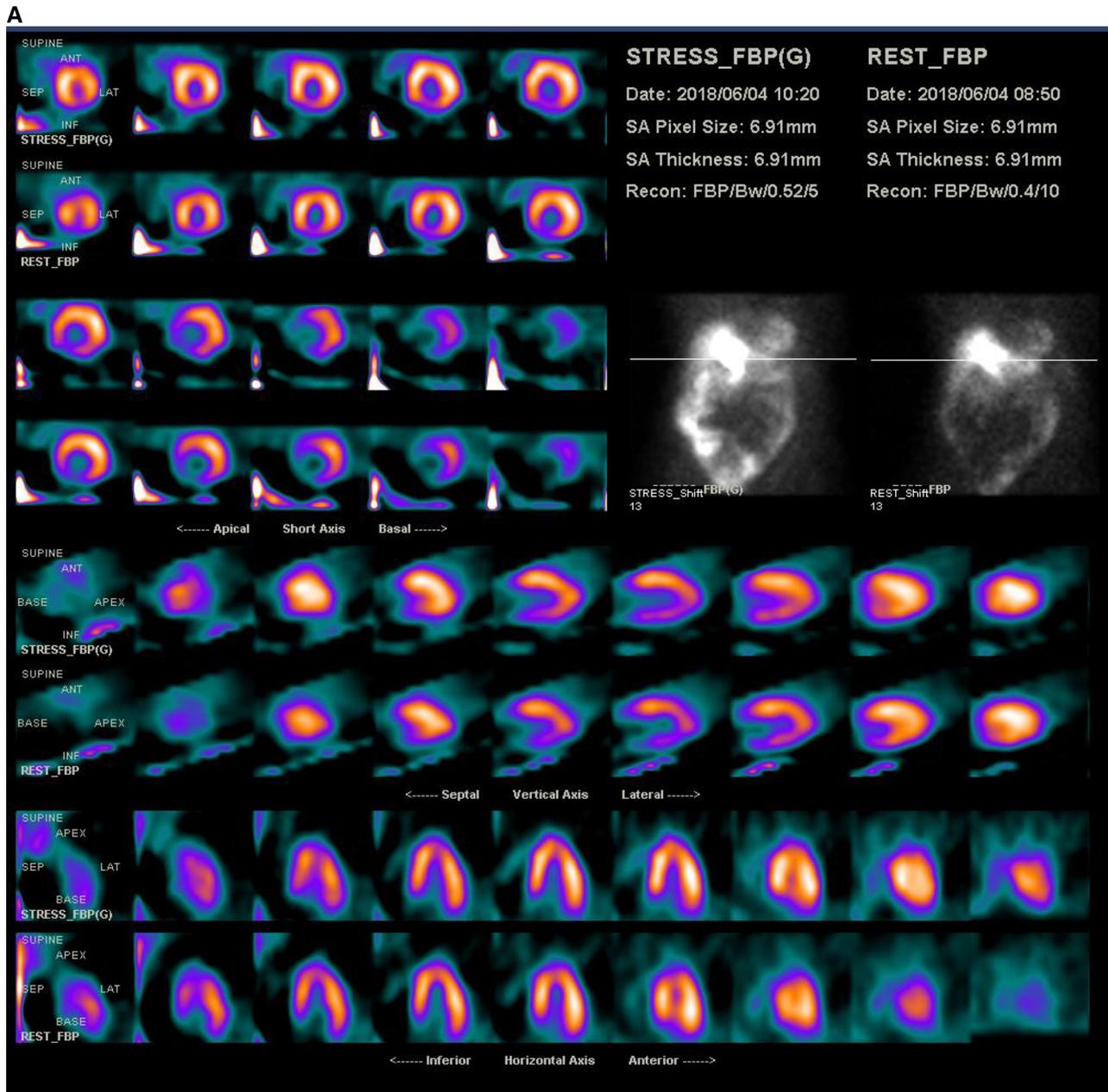
cardiac history, including no history of myocardial infarction or known coronary artery disease. She had undergone a cholecystectomy several years previously for chronic cholecystitis. Otherwise her past medical history was unremarkable.

The patient underwent pharmacologic stress with regadenoson, during which time she experienced no symptoms. The resting electrocardiogram demonstrated

left bundle branch block; therefore the stress electrocardiogram was indeterminate.

Planar projection images demonstrate absence of the gallbladder and very prominent radiotracer uptake in the hepatic and common bile ducts (Figure 1). The right hemidiaphragm is elevated.

Myocardial perfusion SPECT images were first processed using filter backprojection (Figure 2A and B).



**Figure 2.** Filtered backprojection processing. Tomographic images (A) and polar plots (B) demonstrate a moderately extensive, moderately severe fixed defect in the basal two thirds of the inferoseptal wall. The defect is in the *x*-plane of intense activity in the biliary tract. In the reconstructed tomograms (A) marked photopenia is present subdiaphragmatically in the *x*-plane of the intense biliary activity.

There is a moderately extensive, moderately severe fixed defect in the basal two thirds of the inferoseptal wall of the left ventricle. This defect is in the *x*-plane of the intense radiotracer concentration in the biliary tract.

Gated tomographic images demonstrate normal regional wall motion and global left ventricular function (Figure 3A and B). Left ventricular ejection fraction is > 70%.

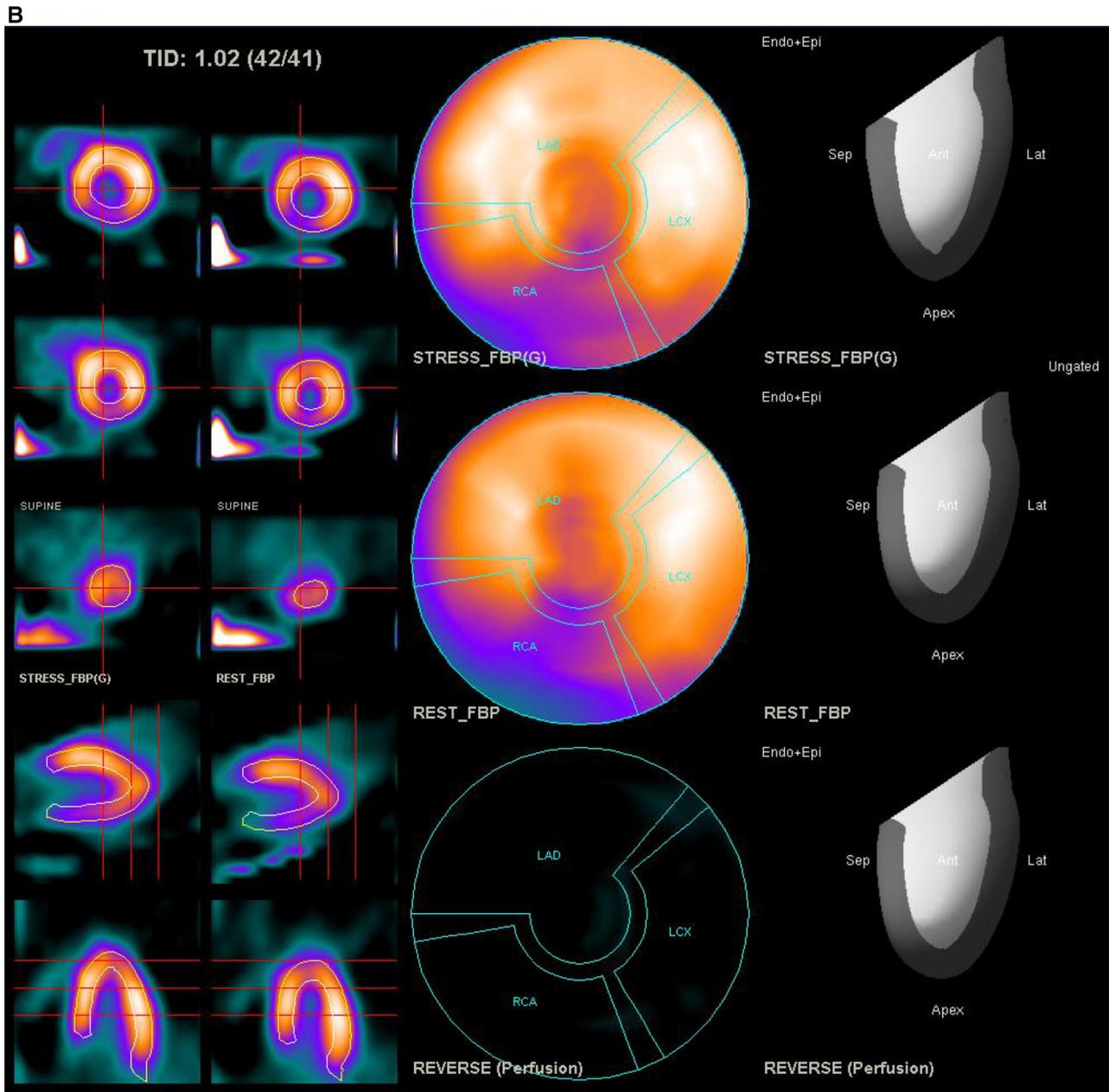
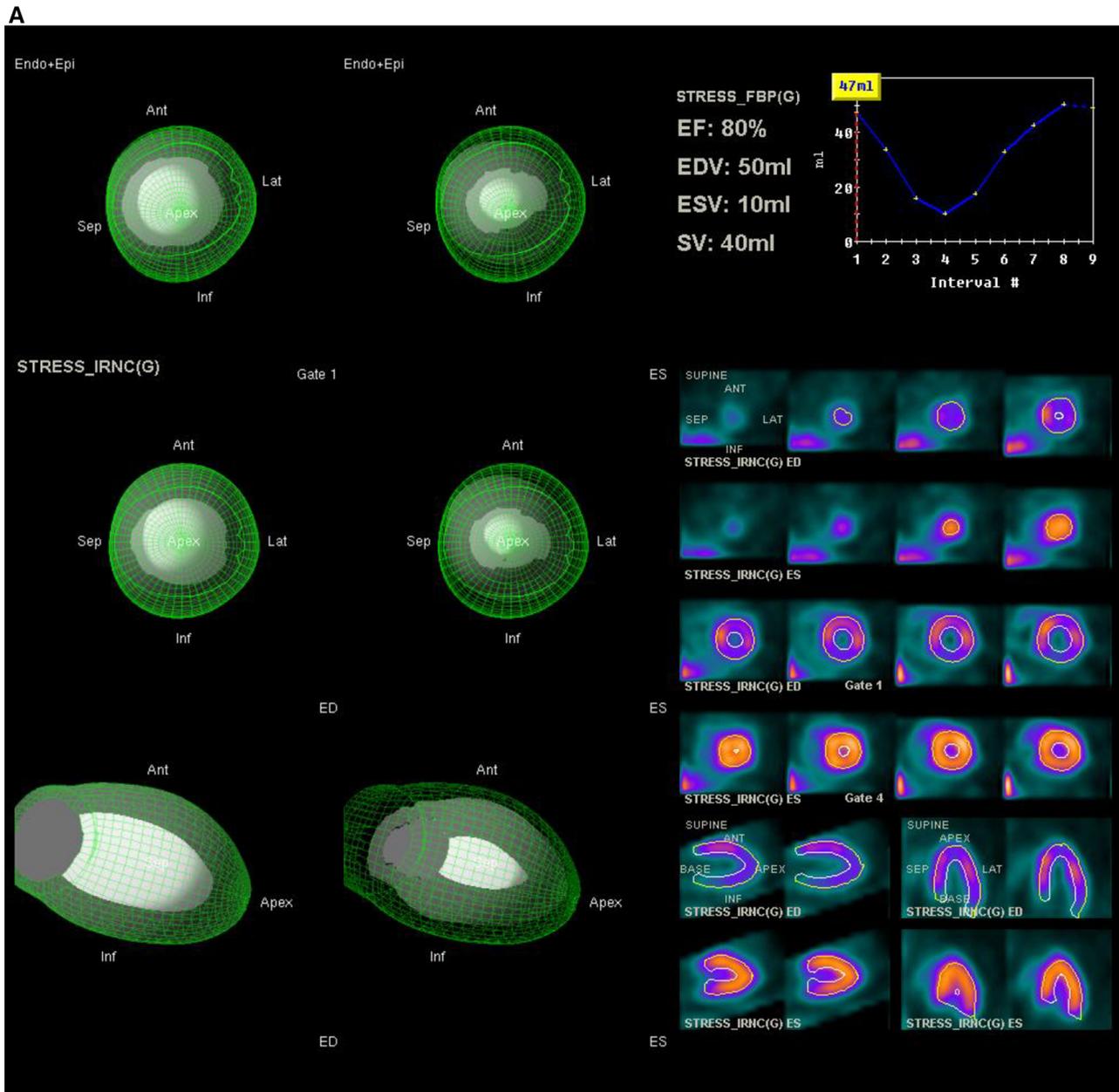


Figure 2. continued.

SPECT images were reprocessed using iterative reconstruction (OSEM) (Figure 4A and B). There is nearly complete resolution of the fixed inferoseptal defect present in the tomograms previously processed

using filtered backprojection. Only a basal inferoseptal fixed defect is present, consistent with the membranous septum.



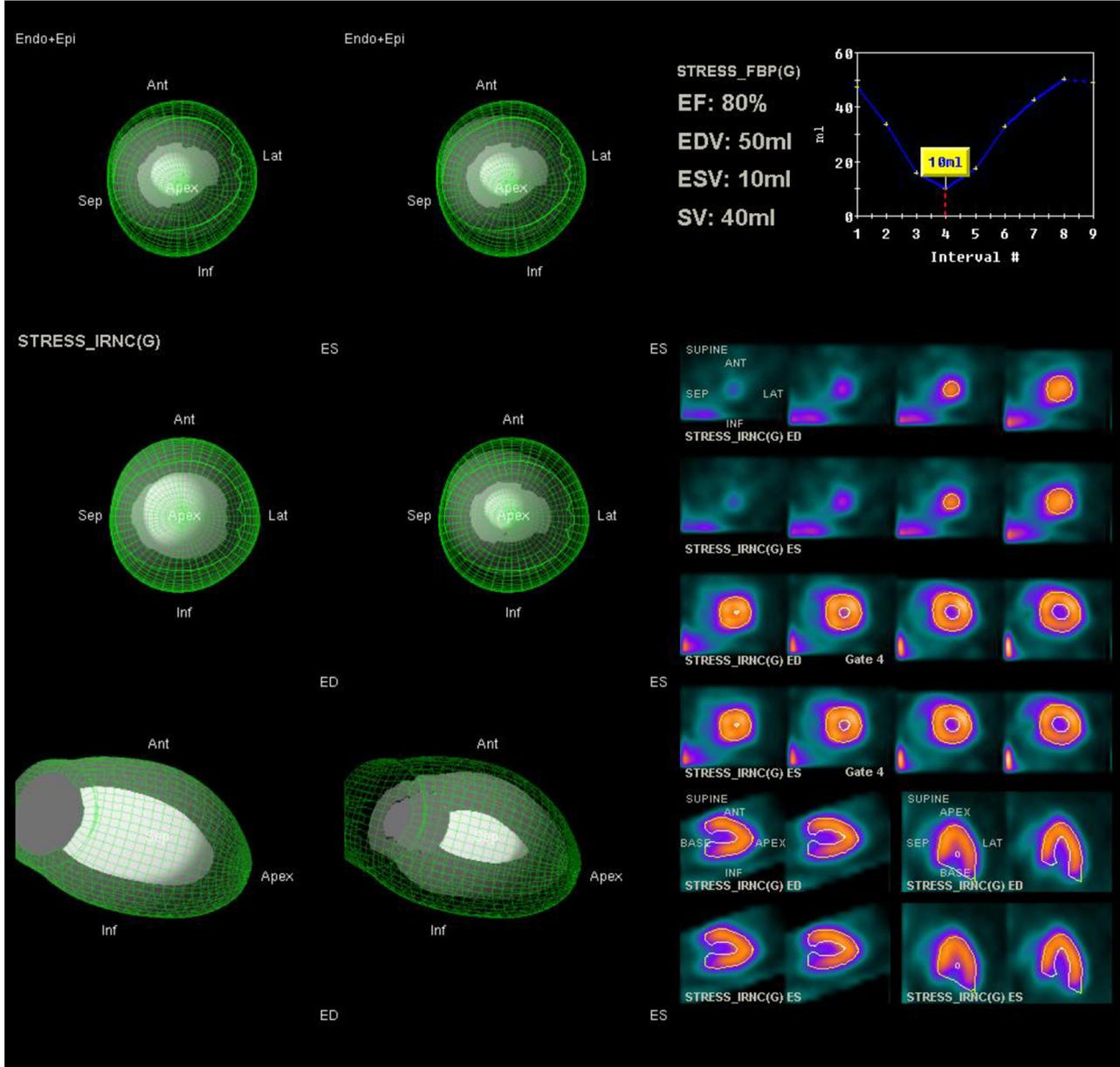
**Figure 3.** End-diastolic (A) and end-systolic (B) gated tomograms demonstrate normal regional wall motion, including that of the inferoseptal wall. LVEF is > 70%.

### DISCUSSION

The Ramp filter artifact is an important cause of myocardial perfusion SPECT artifacts and a source of false positive scans. In the present case example, intense radiotracer concentration was present in the biliary tract

both post-stress and at rest. The Ramp filter artifact therefore resulted in a fixed defect mimicking a myocardial scar. However, the distribution of subdiaphragmatic radiotracer concentration is variable. If subdiaphragmatic activity is only present or more intense post-stress,

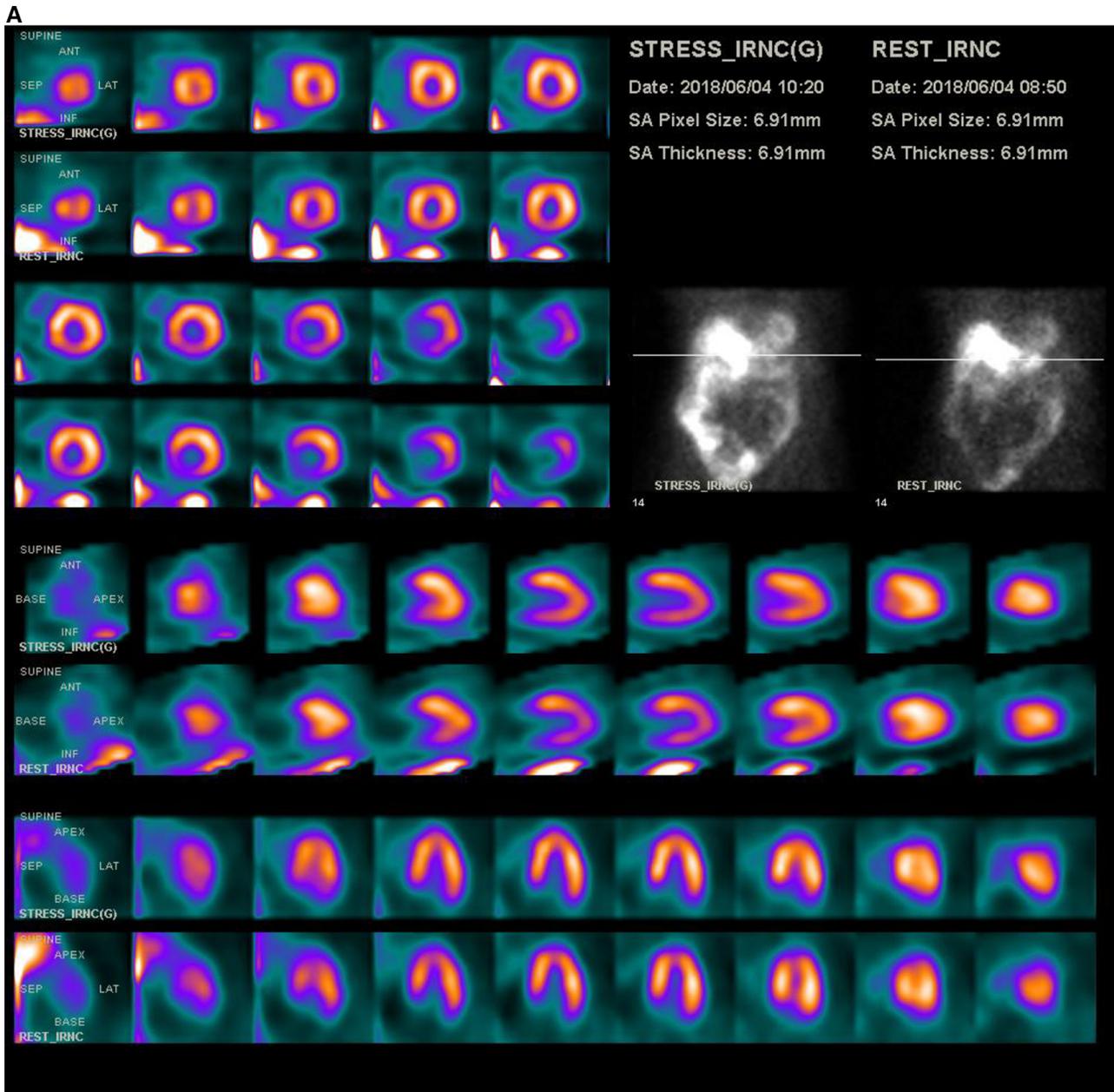
**B**



**Figure 3.** continued.

an artifactual reversible defect may be present, mimicking ischemia. If activity is only present or more intense at rest, a pattern of “reverse distribution” may be present.

In the new ASNC Guidelines there is a recommendation to use iterative reconstruction rather than filtered back projection for myocardial perfusion SPECT reconstruction.<sup>6</sup> Not only is image quality better with iterative



**Figure 4.** OSEM processing. The fixed inferoseptal defect present with filtered backprojection (Figure 2) is resolved. The marked photopenia in the *x*-plane of the intense biliary activity is no longer present. There is a fixed basal inferoseptal defect present, consistent with the membranous septum.

B

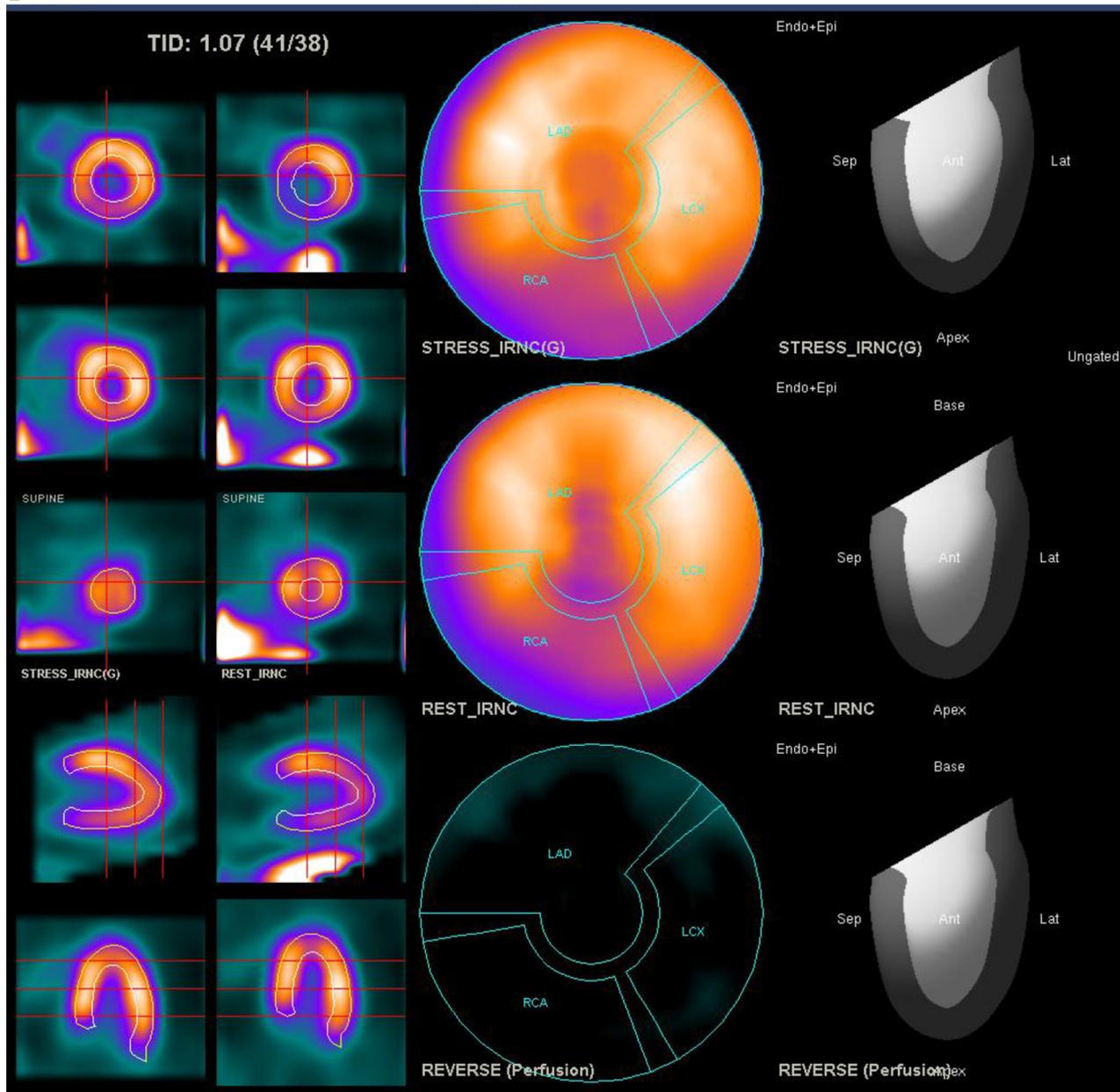


Figure 4. continued.

reconstruction, the Ramp filter artifact is avoided. Hopefully the present case example will reinforce this ASNC recommendation.

#### Disclosure

*E. Gordon DePuey has nothing to disclose.*

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