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Future of Cardiac PET Imaging

Patient Motion During Cardiac PET Imaging

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Patient Motion During Cardiac PET Imaging

Cardiac PET perfusion imaging has been gaining acceptance in the nuclear cardiology community because of higher diagnostic accuracy, faster protocols for patient convenience, lower radiation exposure, and less artifact resulting in fewer false positive studies. Despite these advantages, patient motion during the PET acquisition does occur and can lead to an inconclusive or false positive result. This discussion will describe how it occurs, the appearance of motion on images, and the potential impact on interpretation.

How Motion Artifact Occurs

The Cardiac PET procedure is substantially faster than a SPECT protocol, with each rest and stress Rubidium-82 study requiring only 7 minutes of acquisition. Despite this shortened protocol, patients still move during the acquisition of rest or stress imaging or both, which causes degradation of the resulting image(s). As with SPECT, prevention of patient motion can be accomplished by careful instructions from the technologists, as well as continued encouragement not to move during the data collection. Although motion artifact occurs with both SPECT and PET, PET motion artifact differs from SPECT in two important ways. First, with Cardiac PET MPI, motion correction cannot be performed on a study due to the continuous acquisition of data during the entire protocol. Thus, frame by frame motion correction is not possible, resulting in motion artifact appearing more frequently on the processed PET images. Second, the rotating images cannot assist in the identification of motion, again due to the continuous acquisition and, therefore, motion during the acquisition cannot be identified prior to examination of processed images. Visual recognition of motion artifact in the perfusion PET data is a very important responsibility of the interpreting physician.

The Appearance of Motion Artifact on PET MPI

Descriptively, motion appears as irregular, patchy and sometimes “slit-like” in appearance. It is generally observed throughout the study, although on occasion could be more localized, commonly to the apical segments. Mild to moderate motion does not give the appearance of CAD. As mentioned previously, motion can occur during both the rest and stress acquisitions, or both. A good example of rest motion is shown in Figure 1. In this study, the stress portion is of good quality and is normal without perfusion defects. The rest portion demonstrates generalized motion. At the apical slices, there are contralateral defects in the anterior and inferior as well as septal and lateral walls, seen best on the short axis views. The defects are small and discrete and do not give the appearance of CAD. Further, the LV cavity appears elongated, again, a signal of artifact and often motion. In this example, because the stress portion is normal, the study can be interpreted as completely normal.



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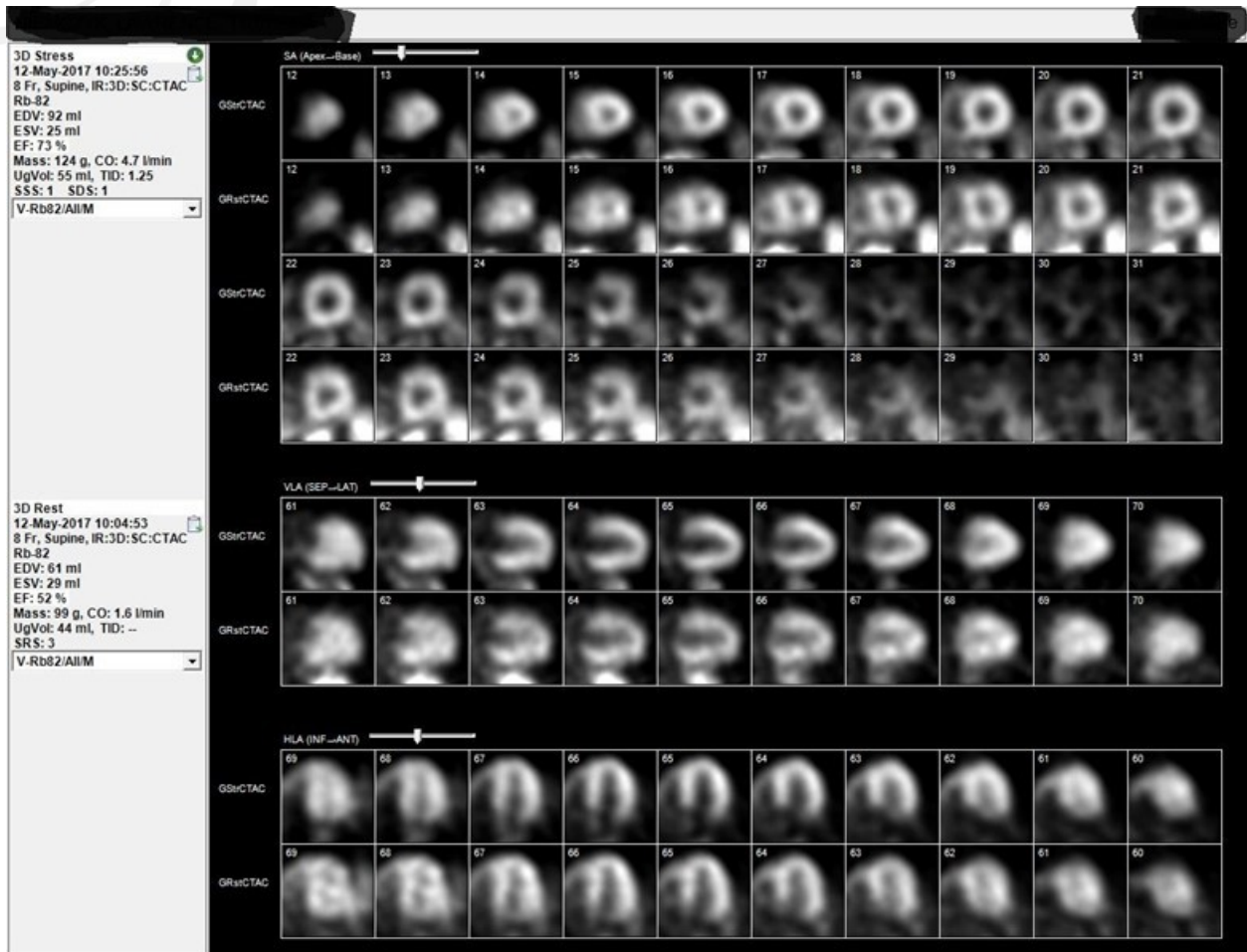


Figure 1. Motion artifact on rest with normal perfusion at stress. It is characterized by irregular and contralateral defects, especially anterior and inferior.

Motion artifact can and does occur with both stress and rest: Figure 2 is an example of when there is motion on both studies. Again, appearance of irregularity in both rest and stress is shown, contralateral defects, not appearing as CAD. Motion on both studies is not uncommon as a patient may be nervous during both acquisitions. As mentioned previously, technologists can work with patients to put them at ease and make them as comfortable as possible.



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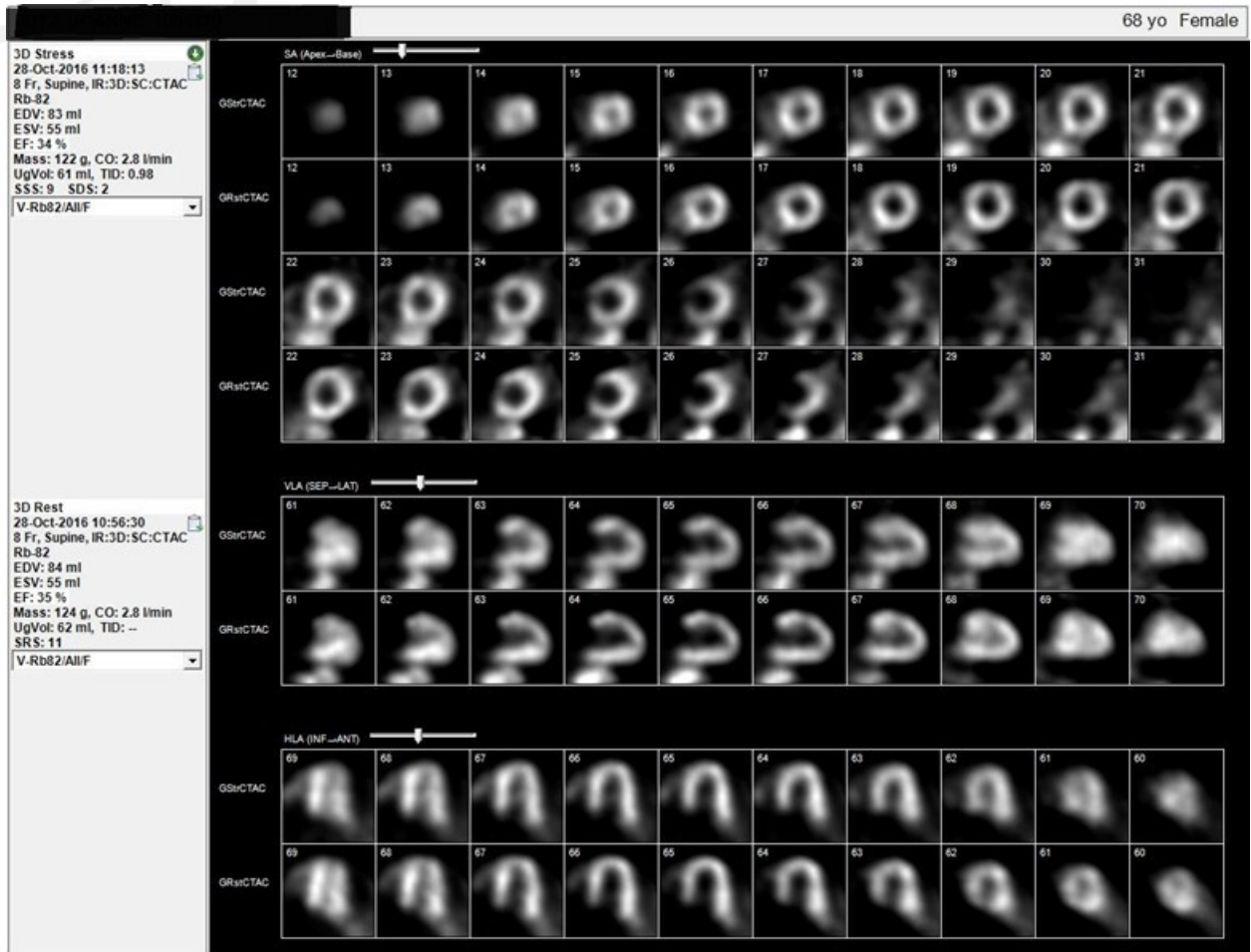


Figure 2. Motion on both stress and rest images

There are various degrees of motion artifact. In Figure 3, below, there is mild motion on stress and rest as shown by the arrows. The images are irregular, not consistent with CAD.

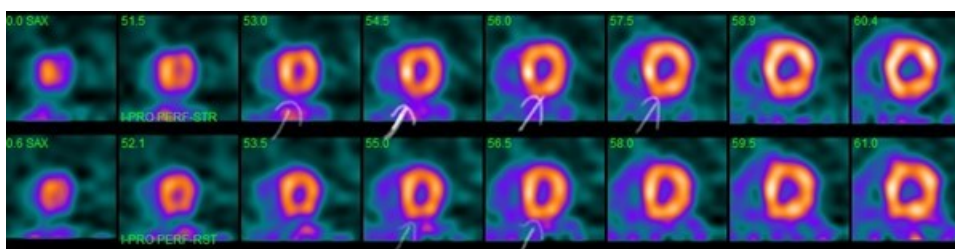
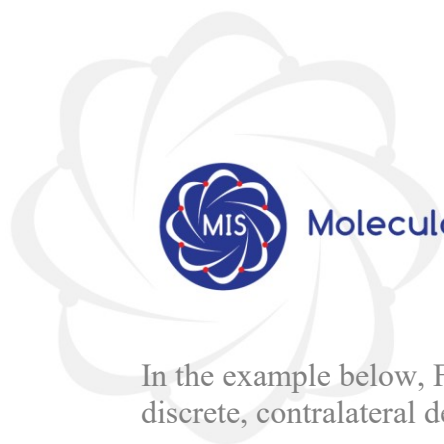


Figure 3: Mild Motion on both rest and stress



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In the example below, Figure 4, there is moderate motion which is characterized by small, discrete, contralateral defects in the anterior and inferior segments, seen on the short axis images.

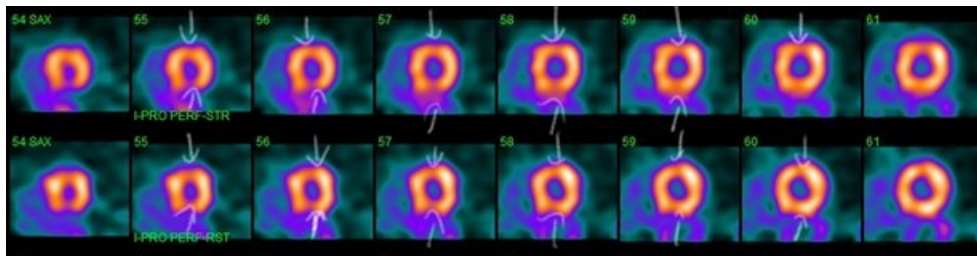


Figure 4: Moderate motion on both rest and stress

Using the Polar Plots to assist in interpretation may in some cases be misleading. For example, in Figure 5, there is motion on stress, not on rest. The polar plot is abnormal on stress, giving the impression that this is a reversible defect. However, the images give the appearance of motion artifact and should be interpreted as such.

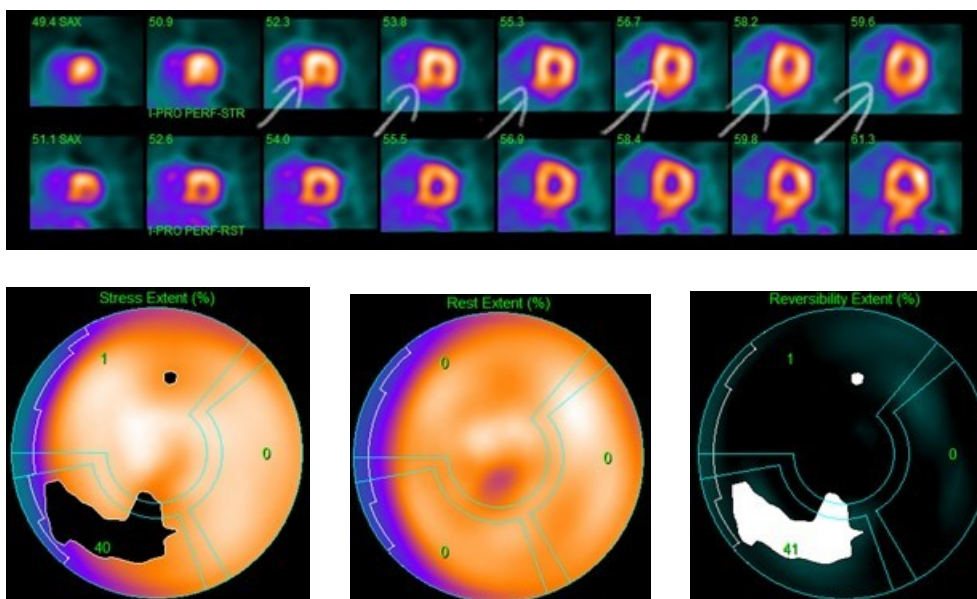


Figure 5: Motion interpreted as a reversible defect on polar plots



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Occasionally, motion is quite severe and very difficult to interpret. This is shown in Figure 6, in which both rest and stress images are very irregular and distorted. In this case, it is very difficult to exclude CAD.

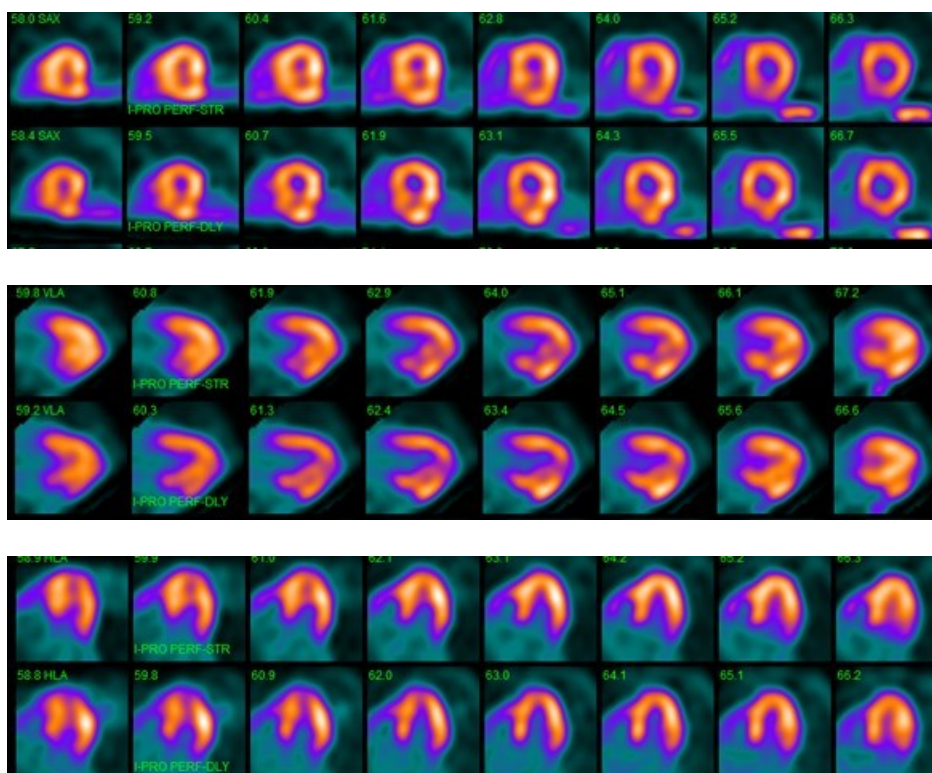


Figure 6: Severe motion resulting in a non-diagnostic study

Interpretation of Images with Motion Artifact

Generally, once the abnormality is identified as motion artifact and does not give the appearance as CAD, the study can be interpreted as normal. For the examples in Figures 1 through 5, this should be the case, including the patient with the polar plot, as long as the interpreting physician is comfortable that the image is artifact consistent with motion. Whether this should be mentioned in the report is an individual decision and depends, again, upon the comfort level of the reader. In a rare situation, such as Figure 6, motion artifact can be so severe that CAD cannot be excluded. The reader then has a choice to consider the study “equivocal” or repeat the study with careful instructions for the technologists.



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Conclusions: Patient Motion with Cardiac PET MPI

Motion artifact occurs with cardiac PET studies despite the shorter protocols. Unfortunately, motion correction software cannot be applied due to continuous acquisition of data, nor can rotating images identify motion. Awareness by technologists of this issue is a strong preventive measure, but despite this, patient motion does happen. For interpreting physicians, recognition of the characteristics is key, and for the most part the study can still be considered normal or abnormal based upon the overall data. Rarely, in cases of severe motion, the study must be repeated or interpreted as equivocal.