Stress-only myocardial perfusion imaging

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Myocardial perfusion SPECT images are routinely obtained in two sets of images, one at rest and another after either exercise or pharmacological stress. There are robust outcomes data that support the standard protocols with two sets of images.[1-3] Therefore, stress and rest SPECT imaging must remain the standard at this time. Nevertheless, in the interest of efficiency and patient convenience, some have considered the selective use of stress-only imaging when the stress images are normal.[4,5] There are limited data that suggest that the idea of stress-only imaging warrants further study and perhaps selective use in expert labs.

Schroeder-Tanka et al[6] reviewed 460 conventional stress–rest technetium myocardial perfusion studies and noted that in 20% of the cases the stress images were entirely normal. They suggested that, in retrospect, resting images added nothing to the interpretation of these studies. Stress images were completely normal in 32% of patients without a history of myocardial infarction, and in 4% of patients with a history of myocardial infarction. In a subsequent prospective study of 235 consecutive patients over 4 months by the same group,[7] 11% of the stress studies were read as definitively normal, and resting studies for these patients were canceled. The clinical outcomes of patients who were judged normal on the basis of stress without rest studies were not examined.

Three studies may have implications for methods of a stress-only strategy. Heo et al[8] compared two single-day Tc-99m sestamibi protocols and found that the protocol that utilized a high dose of technetium for the stress study was better at detecting reversible perfusion defects. This finding suggests that a high dose of technetium may be best for a stress-only strategy, even though that would mean if a rest study were needed, it would need to be performed on a second day. Cheetham et al,[9] on the other hand, found that stress-only imaging could be done with an initial low dose of Tc-99m tetrofosmin for the stress study. For this study, a single experienced nuclear cardiologist reviewed only the stress images from 200 consecutive low-dose stress, high-dose rest studies, and was able to classify 30% of these low-dose stress studies as definitely normal. Comparison with the original complete conventional stress and rest study confirmed the definitely normal stress-only interpretation in all cases. A noteworthy component of this study was that four technologists were also asked to classify the stress-only images as definitely normal or not. In 33% of the cases, the cardiologist judged studies as needing rest images when technologists' interpretations would have classified the study as definitely normal and not requiring rest imaging. This emphasizes that the decision to not do rest images after an apparently normal stress study should be directed by physician interpretation.

Many experts believe that attenuation correction (AC) image processing can help increase the number of stress-only images that can reliably be identified as normal, by reducing soft-tissue attenuation artifacts. Heller et al,[10] asked ten expert nuclear cardiologists to interpret, in a blinded fashion, only the stress images from 90 consecutive low-dose rest/high-dose stress Tc-99m sestamibi studies, without and then with AC. He found that use of AC increased the number of definitely normal stress studies from 20% to 55%. In this study gating did not help to improve the certainty of interpretation. Prone imaging can also be helpful in distinguishing artifact from true perfusion defects,[11,12] and so may prove helpful in a stress-only imaging strategy, a question that is yet unstudied.

Only two studies have reported clinical outcomes of utilizing a stress-only strategy in practice. In a study by Gibson et al,[13] for a period of 2 years (1997 to 1999), patients referred with chest pain and with a low to intermediate pre-test probability of coronary disease were scheduled for a standard two-day stress–rest

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imaging protocol. If the stress images were normal without AC, or if AC normalized stress images, resting imaging was not performed. Of 729 such patients, 37% had significant attenuation artifacts, and could only be read as normal after the use of AC. Clinical follow-up was obtained on 652 (89%) of these patients at a mean of 22 months. There were two non-cardiac deaths, no cardiac deaths, and one non-fatal myocardial infarction. Three patients developed unstable angina, and were found at catheterization to have significant coronary disease. The overall incidence of cardiac events in this group was 0.6%.

The implications of not performing rest imaging when the stress image is abnormal have been investigated in two studies. Santana et al,[14] compared the ability of stress imaging to identify coronary disease with stress and rest imaging; 65 consecutive patients were retrospectively identified, 53 of whom had previous cardiac catheterization. Three readers independently interpreted the dual isotope stress–rest images, and in separate sessions interpreted the stress images only, with all readers blinded to previous interpretations by others, their own previous readings, and to the cardiac catheterization results. Interpretation of stress images performed as well as interpretation of stress and rest images in identifying and localizing coronary artery disease was confirmed by cardiac catheterization in most cases. The overall area under the receiver-operator curve (ROC) was 0.80 ± 0.06 for stress-only images, and 0.78 ± 0.07 for dual-isotope stress–rest images, with similar ROC curves for localization of diseased vessels.

Snapper et al[15] reviewed 59 gated sestamibi myocardial perfusion studies with 72 perfusion defects, to evaluate the potential value of the combination of stress perfusion imaging and post-stress wall motion. They demonstrated that the combination of a perfusion defect with normal wall motion and thickening in the same area on stress-gated images was associated with a high positive predictive value (96%) for detecting ischemia, as compared with stress–rest perfusion imaging. They concluded that the diagnosis of ischemia could be made confidently in patients with visual evidence of wall thickening in an area of a perfusion defect, obviating the need for rest images. However, a lack of wall thickening was less helpful, since 40% of these cases with perfusion defects with wall motion abnormalities (14 segments) demonstrated reversibility on rest perfusion imaging.

DISCUSSION

One of the most powerful prognostic variables described in the myocardial perfusion literature is the summed stress score (SSS), described by Hachamovitch and co-workers.[16,17] This data, and especially the excellent prognosis for a normal or near normal SSS, suggest that a stress nuclear study may often be adequate to assess prognosis, especially when that study is normal. A potential clinical concern with stress-only imaging is the loss of the ability to assess transient ischemic dilatation, and the opportunity to evaluate the decrease in ejection fraction between stress and rest, both of which may rarely be the only clue for significant balanced ischemia.[18] The limited prognostic data available for normal stress-only imaging, as well as the larger prognostic data of a normal SSS, does not support this concern; however, further study would be helpful.

A stress-only imaging strategy approach may be more accurately termed a selective stress-only imaging strategy, in which stress images are obtained and then a decision is made by the interpreting physician about whether to proceed with resting images. If the stress study is completely normal, resting images would not be obtained. A rest study would be obtained if there is any question of an abnormality on the stress study. It may be appropriate at times to consider some non-imaging factors such as a high clinical risk profile or an abnormal ECG response to low-level stress in deciding whether or not to proceed with rest imaging, because of concern for missing important subtle abnormalities such as transient ischemic dilatation.

Patients who cannot exercise are generally at higher risk for cardiac events even after a normal SPECT study.[19] Consistent with this principle, Duvall et al found one-year all cause mortality after a normal pharmacologic stress-only imaging SPECT to be 7.4%, compared with 0% after a normal exercise stress-only image.[20] Therefore, a stress-only imaging strategy may be best applied to patients who can exercise. A stress-only imaging strategy may have less attenuation problems if a high dose of technetium were utilized for the stress images, with rest images if needed performed on a second day. However, a low-dose stress-only strategy has been successfully demonstrated,[9] and allows a one-day testing strategy. Utilization of attenuation correction and prone imaging may help reduce the number of patients that need to return for rest images by reducing attenuation artifacts on the stress images.

Such a selective stress-only imaging strategy has potential to improve patient flow and laboratory utilization, and save time, radiation dose, and cost. It could allow stress nuclear perfusion imaging to provide results within an hour for normal cases, a shorter time than for a conventional SPECT study. Employing a stress-only strategy, however, also has the potential to complicate the logistics of a nuclear cardiology laboratory, with an uncertain and variable number of patients needing rest images on the day after the stress images, depending on the number of stress studies that were abnormal or

equivocal. Careful pre-test risk stratification to limit stress-only imaging to patients with low probability of perfusion defects should reduce the number of patients that need to return for rest images. Attenuation correction and/or prone imaging may also help by reducing artifacts, and so the number of patients who need to return for resting images.

CONCLUSIONS

The best use of a stress-only imaging strategy is likely to be in the selected low or low-intermediate risk population, in whom it is anticipated that the stress study will be normal. The limited data available appears to support the physician-guided highly selective use of this logical approach in this population. The American Society of Nuclear Cardiology believes that for the appropriate use of this strategy it is essential that the interpreting physicians be highly experienced, and that the interpreting physicians make the decisions about who will benefit from resting images. Additional studies in this area are needed, particularly studies addressing clinical outcomes of patients who have decisions made on the basis of stress-only imaging. This strategy does not yet have sufficient data to support a widespread utilization.

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