The exercise ECG: still a useful exercise?

E.E. van der Wall

What is wrong with traditional ST-segment criteria during the exercise ECG? As we all know from daily practice, poor sensitivity of the exercise ECG for the detection of myocardial ischaemia is a major diagnostic weakness and a critical limitation of the exercise procedure. In standard meta-analyses, 1.0 mm (0.1 mV) of horizontal or downward-sloping ST depression has a sensitivity of only 68% for the detection of coronary artery disease (CAD), and this figure is even lower for women. This might explain our increasing reliance on noninvasive imaging modalities such as nuclear imaging (SPECT), magnetic resonance imaging (MRI), and computed tomography angiography (CTA), all of which show sensitivities between 80 and 90% for detecting CAD. As a result, there is a tendency to consider the exercise ECG as a poor man's procedure to demonstrate myocardial ischaemia due to CAD. Is this the right consideration?

Routinely, we judge our exercise ECGs (apart from functional capacity and blood pressure response) by the magnitude of ST-segment depression for the definition of ischaemia. We usually only focus on ST-segment changes in the left precordial leads, lead V₅ being most prominent. Because ST-segment depression is largely driven by the progressively increasing exercise workload, 1.0 mm of ST-segment depression (which is empiric!) is not a physiologically stable marker for the identification of the presence or the extent of CAD. As a consequence, peak exercise ST depression is the wrong variable for the evaluation of coronary disease. Therefore, the magnitude of ST-segment depression alone at peak exercise does not work very well for the identification of presence and severity of CAD.

To derive more useful information from the exercise ECG, one has to look for other parameters that might improve sensitivity, such as dynamic changes in ST-segment depression and changes in heart rate. From physiological studies, it has been shown that ST-segment depression during exercise-induced ischaemia is related to the product of the extent of disease and changes in heart rate. Heart rate change is known to be linearly related to myocardial oxygen demand. Once the ischaemic threshold is reached, changing heart rate drives changing ST depression independent of the extent of disease. As a result, heart rate is a more relevant physiological parameter for detection of ischaemia than exercise duration. To adjust changes in ST-segment depression for corresponding changes in heart rate during exercise, the ST/HR index has been proposed.¹ The ST/HR index is obtained simply by having the overall additional change in ST depression from rest to peak exercise in the lead with the maximum ST depression divided by the overall change in heart rate during the course of exercise. The ST/HR index controls for the increasing metabolic severity of ischaemia that accompanies exercise. Using the ST/HR index, ST depression is measured 60 ms after the J-point, regardless of the upward-sloping, horizontal, or downward-sloping nature of the ST-segment depression. When applying the ST/HR index in a large number of patients with proven CAD (using a cut-off value of 1.6 μ V/bpm), the ST/HR index improved the sensitivity of the exercise ECG from 68 to 90%, with no significant fall in specificity! Interestingly, improvement in sensitivity was even greater in women than in men with the use of the ST/HR index. Determination of the ST/HR index is simple and does not require any complex analysis tools, but just simple division of overall change in maximum ST depression by the change in heart rate during exercise. Of course, automatic computer-assisted analysis would enhance routine application of the index.

In summary, simple heart rate adjustment of ST-segment depression during exercise ECG can improve identification and assessment of underlying CAD. Using the ST/HR index, considerable improvement of sensitivity of the exercise ECG results from the reclassification of otherwise 'equivocal' and even 'negative' test responses, including increased identification of one-vessel CAD in men and women. Used in this way, the exercise ECG remains a useful exercise for the detection of myocardial ischaemia. ■

E.E. van der Wall

Department of Cardiology, Leiden University Medical Center,
Leiden, the Netherlands

E-mail: e.e.van_der_wall@lumc.nl

Reference

- 1 Kligfield P. Principles of simple heart rate adjustment of ST segment depression during exercise electrocardiography. *Cardiol J* 2008;15:194-200.