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HyperQ—new horizons in ischemia detection

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Electrocardiogram (ECG)-based ischemia detection is typically based on identifying changes in the ST-T segment, yet with limited accuracy. Analysis of high-frequency QRS components, which quantifies changes in the depolarization phase of the cardiac cycle, has been previously reported to better identify ischemia. BSP Ltd (Tel Aviv, Israel) presented a new, Food and Drug Administration–approved technology to monitor and quantify changes in the high-frequency QRS components (HyperQ) during exercise, based on sophisticated ECG signal analysis (Fig. 1). Several studies aimed at assessing the clinical diagnostic value of the HyperQ System in detecting demand-induced ischemia have been performed. A large-scale clinical study aimed at evaluating the HyperQ during routine treadmill exercise test to detect induced myocardial ischemia.[1] Exercise myocardial perfusion single-photon emission computed tomography (SPECT) was used as the gold standard for comparison. The study was performed in 885 consecutive patients. The relative intensity change of HyperQ during exercise was used as an index of ischemia (see Figs. 2 and 3). Logistic regression was used to assess the incremental diagnostic value of HyperQ data over conventional ECG analysis and clinical parameters. The HyperQ index of ischemia was found more sensitive than conventional ST analysis (78% vs 56%, $P < .01$) with similar specificity (74% vs 78%, P = NS). The HyperQ index offered a significant incremental diagnostic value over clinical symptoms and stress test data. Another important finding was that changes in the HyperQ signal were observable before ST changes were evident, indicating an early detection of ischemia by the HyperQ.

In a research project performed at the Rabin Medical Center, Israel, HyperQ and conventional ECG were obtained in 95 patients undergoing exercise myocardial perfusion SPECT.[2] The HyperQ index of ischemia exhibited enhanced sensitivity and specificity relative to conventional ST analysis (76% vs 59% [$P < .01$] and 85% vs 57% [$P < .01$], respectively).

Data from a study that was carried out at the Charleston Area Medical Center, West Virginia, were reanalyzed and compared with exercise myocardial perfusion SPECT in 133 patients.[3] The HyperQ index of ischemia was found more sensitive than the conventional ST analysis (77% vs 43%, $P < .05$) with comparable specificity (66% vs 57%, P = NS). In patients with inconclusive ST changes, HyperQ analysis correctly identified 17 of 21 subjects. In women, HyperQ analysis resulted in improved specificity relative to conventional ECG (70% vs 33%, $P < .05$).

The HyperQ System was also tested for its detection capabilities under conditions of supply ischemia.[4] HyperQ data were obtained in 34 patients undergoing short intracoronary balloon occlusions. The analysis of HyperQ signals exhibited marked improvement in the sensitivity of ischemia detection vs analysis of ST changes (94% vs 44%, $P < .001$).

In conclusion, HyperQ analysis presents a significant improvement to current stress ECG in detecting ischemia and may thus aid in enhancing the noninvasive diagnosis of ischemic heart disease. This technology offers a new technique, in addition to currently used ones, to the arsenal of noninvasive diagnostic capabilities of the cardiologist.

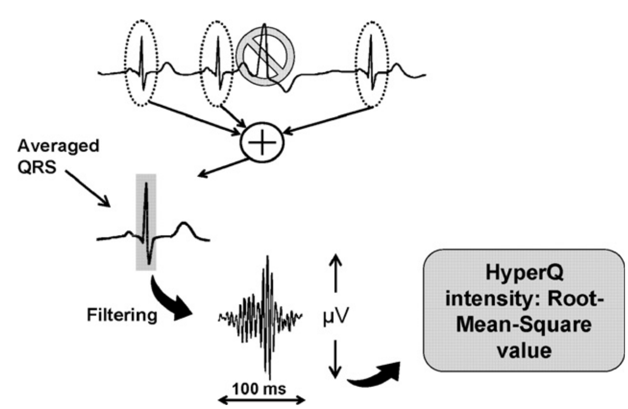

Fig. 1. A schematic flow of the production of the HyperQ signal. First, QRS complexes are detected, while rejecting arrhythmias and noisy complexes. The detected QRS complexes are carefully aligned and averaged. The averaged QRS complex is then filtered in the 150- to 250-Hz band to produce the HyperQ signal. HyperQ intensity is obtained by calculating the root mean square value of the HyperQ signal. Plotting consecutive values of HyperQ intensity results in time-intensity curves showing the dynamics of the signal.

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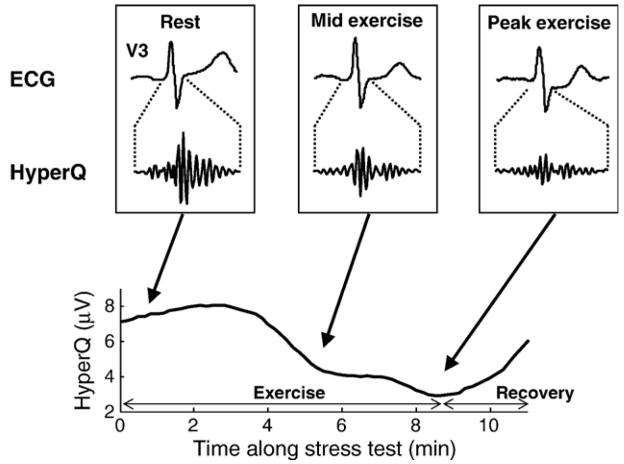

Fig. 2. An example of the HyperQ time intensity curve (bottom panel) obtained in 1 lead from a patient with extensive stress-induced ischemia in the left anterior descending coronary artery territory. ECG and HyperQ signal are shown at rest (top left), mid exercise (top, middle) and at peak exercise (top, right). Note the marked decrease in HyperQ intensity with exercise, indicating ischemia.

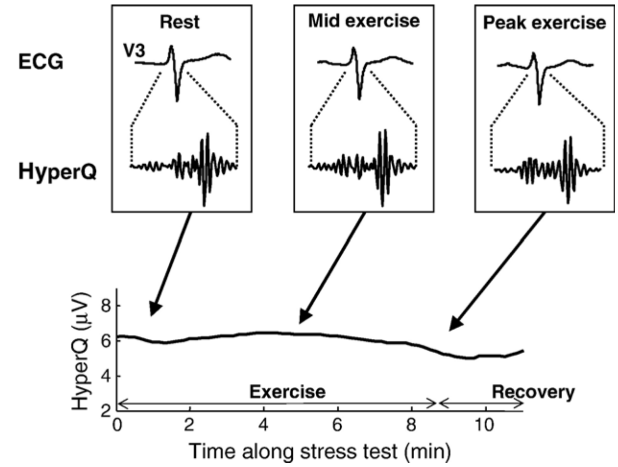

Fig. 3. An example of the HyperQ time intensity curve (bottom panel) obtained in 1 lead from a patient with normal perfusion. ECG and HyperQ signal are shown at rest (top left), mid exercise (top, middle) and at peak exercise (top, right). HyperQ intensity changes only slightly during exercise, indicating normal perfusion.

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