Editorial Comment

Role of Atrial Repolarization in False Positive Exercise Tests*

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The report by Sapin and colleagues (1) in this issue of the Journal describing the effect of atrial repolarization on the ST segment is an important contribution. They have revisited long-held concepts about the Ta wave and applied it to clinical cardiology in a way that may turn out to be useful.

Clinicians and physiologists alike have long struggled to explain why there are so many "false positive" ST segment abnormalities (2,3). It is now recognized that there are many reasons why the myocardium may become ischemic during exercise in the absence of significant epicardial coronary disease (4–6). Even so, there are undoubtedly many persons who develop exercise ST depression in the absence of ischemia and it seems likely that atrial repolarization may explain some of these events.

The Ta wave: effect on the ST segment. The possibility that the Ta wave might affect the ST segment was proposed as early as 1936 by Shipley and Halloran (7) in their analysis of 200 electrocardiograms (ECG) in normal men and women. Lepeschkin's diagram (8) published in 1958 clearly depicts the timing and magnitude of atrial repolarization and establishes the groundwork for the present report (Fig. 1). However, to apply this clinically it was necessary to learn more about the duration, direction and amplitude of the Ta wave. This information was obtained by several workers in the early 1970s, often by studying atrial repolarization in patients with complete heart block (9–11). The report by Hayashi et al. (12) is of special importance and their figure clearly illustrates the effect of the Ta wave on the ST segment (Fig. 2).

These studies suggest, however, that in most patients the Ta wave should be expected to produce its maximal effect on the J point, resulting in an upsloping ST segment reaching the baseline before the usual J+80 ms point considered standard for ST measurement. However, if the P plus Ta interval becomes as long as 400 ms, which may occasionally occur, a simple addition follows: PR = 180 ms, plus QRS = 100 ms, leaves a 120 ms overlap into the ST segment, which can easily cause ST depression of clinical significance (9,10).

As the P wave amplitude increases with exercise (9), as well as with right atrial hypertrophy (13), the increasing amplitude of the Ta wave becomes even more important.

The Present Study: Problems

Although the concept of using the Ta wave to identify false positive exercise tests has considerable appeal, the study of Sapin et al. (1) has some serious limitations.

Patient identification. Sixteen of the 25 patients with a "false positive" result were categorized by an abnormal nuclear imaging study. The sensitivity of the thallium exercise test or a gated pool study in a group of asymptomatic patients is far from 100% (14). In a recent study of 186 asymptomatic patients in our laboratory (unpublished data), there was a false negative rate of 41% on thallium scintigraphy. Many of the patients in the cohort in the present study (1) who had a false negative thallium test had abnormal ST changes. Thus, the identification of their patients with a false positive result is less than optimal.

Measurement of the PQ segment. Although reproducibility of evaluation of the PQ slope was quite high in this study (1), the authors did not mention whether they used the computer-generated median beat or the raw data. Figure 3 indicates the difficulty of estimating a slope in a segment that is usually <40 ms long. Perhaps a computer-generated slope from the median beat might be more reliable. It appears from careful observation of many exercise ECGs and from the work of Riff and Carleton (9), that the slope is rate related and, thus, the faster the heart rate, the greater the probability of a steep PQ slope. Thus, the diagnosis of a false positive result based on the PQ slope may be dependent more on a high heart rate rather than on the Ta wave.
Shape of the Ta wave. Figure 2 in this editorial and Figure 5 from the report of Sapin et al. (1) illustrate the shallow, symmetric nature of the Ta wave, characteristics that appear to be unlikely to produce a horizontal ST segment. The maximal deflection would be expected to fall at or near the J point and to result in an upsloping pattern of rather modest magnitude.

Conclusions. In summary, the concept deserves further study in a group of patients with angiographically documented false positive ST segment depression. The empiric fact that ST depression in the inferior ECG leads is less reliable than that in other leads because of atrial repolarization has long been recognized (15). It may be that the slope of the PQ segment would provide an estimate of the magnitude of the Ta wave effect on the ST segment and thus will help reduce the number of patients who are ultimately found to be false positive responders.

Although the data presented by Sapin et al. (1) do not adequately demonstrate the clinical utility of the method, they suggest several questions that need to be answered: 1) How does ischemia alter the Ta wave? It is known that the P wave responds to changes in diastolic pressure with increases in both amplitude and duration (16). 2) Does repolarization of the atrium produce a voltage change that would cause a horizontal or downsloping ST segment? 3) What are the physiologic events that initiate these changes? 4) How can we best detect these events in the ECG?

Sapin et al. (1) are to be congratulated for stimulating interest in an area of importance. If others can confirm their thesis and answer some of the questions raised, a major contribution to exercise testing may evolve.

References