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ST forces during exercise. Quantitative comparison of electro- and vectorcardiograms and findings at coronary arteriography

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Summary

It was the aim of this study:

1. To determine the diagnostic value of various criteria of exercise electrocardiography and vectorcardiography.
2. To evaluate the significance of some of these criteria in predicting the anatomical localisation of coronary artery obstructions.

For the purposes of this investigation use was made of electrocardiographical information recorded during graded exercise tests in patients suspected of having obstructive coronary artery disease. The patients were studied because they had previously complained of chest pain. All were free of cardiac abnormalities not directly attributable to coronary disease. Electrocardiograms recorded at rest showed normal repolarisation in all patients. Many of the patients were included in this study because the clinical results of previous exercise tests had been negative.

Selective coronary angiography was performed in 87 patients. The exercise tests were carried out on a bicycle ergometer. Stepwise increases in work load were made until one of the stop criteria registered. We attempted to reach a work load which produced a heart rate of at least 90% of the age-corrected predicted maximum heart rate.

During test and recovery, ECG signals from 5 leads were recorded, using the so-called bipolar thoracic leads with a common electrode at the V5 position. Using the electrical information derived from 4 of these leads, it was possible, by means of a transformation procedure, to approximate closely to the vectorcardiographic representation of Frank. This procedure enabled us to compare simultaneously recorded ECG signals with computed vectorcardiograms. From a quantitative analysis of changes in certain characteristics of the repolarisation wave during exercise, a prediction was made of the presence or absence of coronary obstruction as demonstrated by coronary angiography. These predictions were made in the form of a binary (yes or no) decision, and displayed in so-called contingency tables.

The most commonly used criterion of the ECG, the ischaemic ST segment, was used for the visual analysis of the ECG's. In the literature, and in previous studies in this department, this sign was considered positive if junctional de-

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pression of 0.1 mV or more, followed by a horizontal or sagging ST segment of at least 80 msec. duration occurred during exercise. This was considered to be an a priori criterion. Various electro- and vectorcardiographic parameters were analysed by digital computer. Some of these parameters have already been described in the literature. These are:

- the ST slope
- the SX integral
- the length-width ratio of the T-loop
- the directions of the instantaneous ST vectors.

To the best of our knowledge, no study has yet been published in which the diagnostic value of each of these parameters was assessed and mutually compared. The critical value at which each parameter was considered to indicate the presence or absence of coronary disease was, in some cases, derived from the literature. These were termed a priori criteria. Critical values only optimised after comparing the results with arteriographic findings were termed a posteriori. The diagnostic results of visual inspection, using ischaemic ST depression as the criterion, were poor. This can be partly attributed to the basis of selection of our patients, however.

The best diagnostic results were obtained from:

1. automatic analysis of the direction of the instantaneous ST vectors 70 msec. after the end of the QRS complex (XVCG, ST 70).
2. analysis of the ST slope between 10 and 50 msec. after the end of the QRS complex, together with the ST depression at a point 10 msec. after the end of the QRS complex [$\Delta V/\Delta t$ (10-50, ST(10))].

The last parameter would seem to be particularly promising, since the maximum amount of diagnostic information could be derived from it by recording a single lead during the period of maximum work load. The SX integral appeared to yield the best diagnostic results of all the a priori criteria. It seemed to be impossible to estimate the anatomical position of coronary artery obstructions with any degree of accuracy from electro- or vectorcardiographic changes.