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Letter to the Editor

Heart rate adjustments and analysis of recovery patterns of ST-segment depression in type 2 diabetes ☆

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Abstract

Aims: To investigate the diagnostic value for coronary artery disease (CAD) detection of evaluating time- and heart rate (HR)-related ST-segment changes (the ST/HR-slope) and the post-exercise recovery pattern (the ST/HR-recovery loop) in patients with type 2 diabetes mellitus (T2DM).

Methods and results: Ninety-one patients (22 female, age 59±9 years) with T2DM (diabetes duration 6±6 years) performed an exercise ECG-test that was evaluated using the ST/HR slope (cut-off ≤ −2.4 μV/bpm) and -recovery loop patterns (abnormal versus normal) and compared to the conventional ≥1 mm ST-segment depression criterion and dobutamine stress echo-cardiography, all evaluated against coronary angiography irrespective of stress test results. Coronary angiography revealed CAD in 20 men and 3 women (25%). Sensitivity for the conventional exercise test and stress echocardiography was low (0.35 and 0.30), but increased significantly using the ST/HR-slope (0.45), the recovery loop (0.86) or the combined ST/HR slope and recovery loop criterion (0.91). The associations between angiographic CAD-detection and the different tests expressed by the Odds ratio demonstrated an added value of performing ST/HR analysis both over pre-test CAD risk profile and the established techniques.

Conclusion: T2DM patients capable of performing an exercise test could be assessed with the ST/HR-analysis for selecting patients to angiography. However, further studies including a higher number of patients are needed to confirm the diagnostic value of this approach.

Keywords: Coronary artery disease; Type 2 diabetes mellitus; Diagnosis; ECG; Stress echocardiography

Asymptomatic coronary artery disease (CAD) is prevalent in patients with type 2 diabetes mellitus (T2DM) [1,2]. Among these patients the clinical usefulness of several non-invasive tests, such as standard exercise ECG (≥1 mm ST-segment depression), have been limited by poor sensitivity for diagnosing CAD [2,3]. Among non-diabetic subjects, evaluation of time- and heart rate (HR)-related changes in ST-segment depression (the ST/HR-slope) [4] and the post-exercise recovery pattern (the ST/HR-recovery loop) [5] during an exercise test have improved the diagnostic value. However, these criteria have not been reported in patients with T2DM and were therefore examined together with stress echocardiography for detection of CAD diagnosed by coronary angiography, irrespective of results from non-invasive tests.

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We recruited 91 CAD-asymptomatic patients (22 female, age 59±9 years) with T2DM (diabetes duration 6±6 years, HbA1c 7.5±1.6%, body mass index 30.2±5.6 kg/m^2, 9 previously CAD diagnosed) after written informed consent. The study was conducted according to the Helsinki declaration and approved by the Regional Ethics Committee. Procedures for clinical examination, analysis of fasting blood samples, standard exercise ECG-test and coronary angiography are described previously [2]. The ST/HR-slope was computer-calculated [6] using linear regression of all ST-amplitude and HR data (obtained every 10th sec) during the last 4 min of exercise. The steepest (most negative) ST/HR-slope value (expressed in microvolt (μV)/beat per minute (bpm)) of the precordial leads (V1–V6) was classified as pathological if ≤−2.4 μV/bpm [4]. The computer generated ST/HR-recovery loop [6], evaluated in the same lead, was semi-quantitatively classified as counterclockwise (normal) or clockwise or figure 8 (pathological, Fig. 1) [5].

Dobutamine stress echocardiography (Vivid 7/5 scanners, GE Vingmed Sound, Horten, Norway) followed a staged protocol and was interpreted by an independent experienced observer blinded for other test results, according to literature [7]. A positive test was defined by new or progressing wall motion abnormality in ≥1 segment of 16 left ventricular segments scored.

Coronary angiography was performed according to standard procedures irrespective of results from non-invasive tests. They were independently analysed by two experienced cardiologists blinded to the ECG results (inter-observer variability 4.4%). Significant CAD was defined as the presence of ≥50% luminal diameter narrowing of one or more of the epicardial arteries or its major branches.

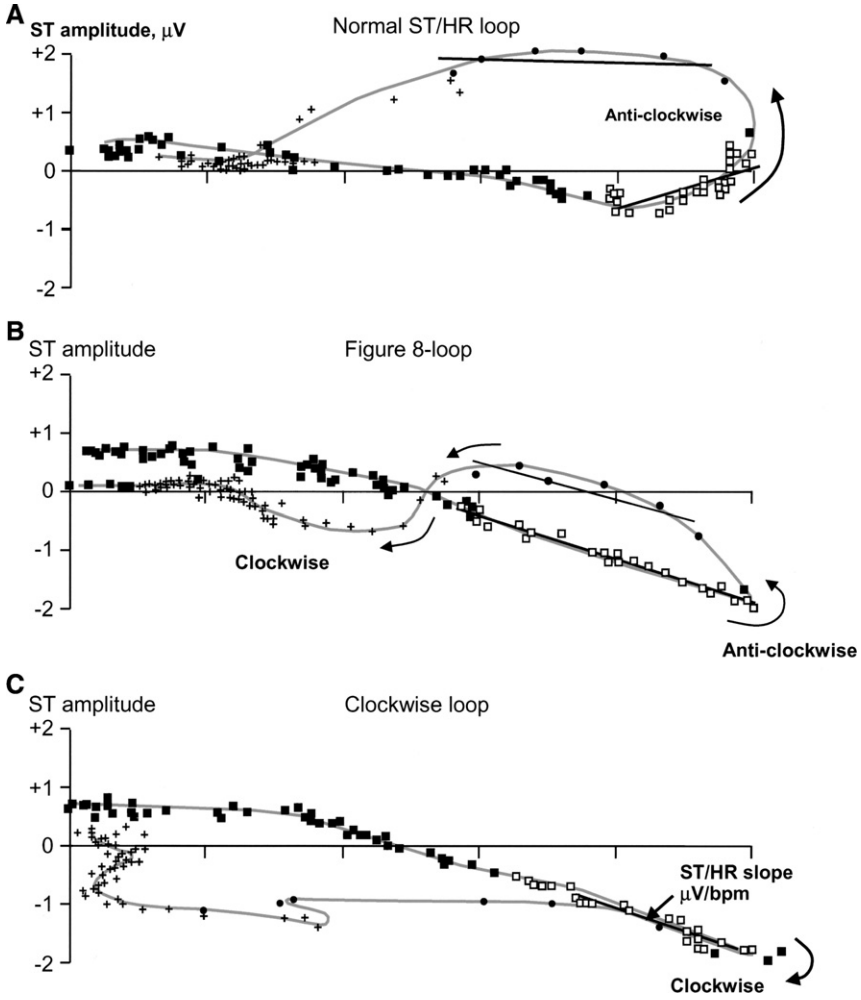

Fig. 1. Recovery patterns (ST/HR-loops) of ST-segment depression; (A) The normal recovery pattern, (B) the pathological figure 8 loop and (C) the pathological clockwise-loop. Plotted are consecutive ST60-amplitude values versus heart rate every 10 s during and after exercise. The largest positive ST-amplitude value is given the value +2 and the largest negative is given the value −2. The left part of the *x*-axis represents the resting heart rate and the furthermost right part represents the maximal heart rate. Filled squares: values at rest and during exercise, Open squares: values obtained during the last 4 min of exercise, filled circles: values obtained during the first minute after end of exercise, +: values during the remaining part of the recovery period. The ST/HR-slope in (A) is positive while the corresponding ST/HR-slope in (B) is −7.8 μV/bpm and in (C) −4.1 μV/bpm. The criterion for a figure 8 loop was that the recovery-curve initially was counter-clockwise, but then crossed within two minutes of the recovery period. Abbreviations: HR — heart rate, μV — microvolt, bpm — beats per minute. Reproduced with permission from Scand Cardiovasc J 2004; 38:270–277.