Adenosine echocardiography – an alternative to dynamic stress echocardiography

Vuk G. Kujacic, Dalia Jablonskiene & Håkan U. Emanuelsson
Division of Cardiology, Sahlgrenska Hospital, S-413 45 Göteborg, Sweden

Accepted 1 December 1992

Key words: adenosine, angina pectoris, exercise echocardiography

Abstract

Dynamic exercise echocardiography is sensitive and specific in detection and evaluation of coronary artery disease. Frequently, however, patients cannot achieve maximum exercise because of various factors. The aims of this study were to compare usefulness of adenosine infusion and dynamic exercise to induce myocardial ischemia detected with 2-D echocardiography and standard electrocardiography; to determine the sensitivity of the adenosine echo test; and to evaluate the safety and tolerability of adenosine infusion.

In 31 men with clinical diagnosis of stable angina pectoris, myocardial ischemia was induced by: a) symptom-limited exercise test on a bicycle, and b) intravenous adenosine infusion. The two tests were performed with an average interval of 24 hours. Coronary angiography was performed in 29 of 31 patients and significant coronary artery disease (diameter narrowing >50%) was documented in 26 of these (12 single, 6 two- and 8 three-vessel disease). The criterion for echo positivity was a transient impairment of contraction as compared to the baseline examination in any of 10 segments, with an increase of left ventricular score index of 0.3 or more. ECG positivity was considered as ST_{60} segment depression of 0.1 mV or more from the reference level in any lead.

Adenosine echo test was positive in 22 out of 26 patients and exercise echo in 19 (sensitivity 85% and 73%, respectively, p = NS). Adenosine ECG test was positive in 14 of 26 patients and exercise ECG test in 21 (sensitivity 54% and 81% respectively, p = NS). In three patients with normal coronary arteriography adenosine echo was negative in all three, exercise echo, adenosine ECG and exercise ECG in two. Side effects due to adenosine infusion were always minor, well tolerated by the patients and disappeared within seconds after termination of infusion. The present study suggests that adenosine test is at least as useful as exercise echo test in the provocation of myocardial ischemia in patients with coronary artery disease and stable angina pectoris.

Introduction

Dynamic stress electrocardiography has for several decades been the standard method for the diagnosis and assessment of patients with coronary artery disease. Echocardiographic evaluation during or immediately after exercise has proven useful in achieving additional information in these patients, in particular regarding regional myocardial dysfunction during stress [1-4].

The use of pharmacological provocation as an alternative to exercise may carry potential advantages. For example, it can be used in patients unable to achieve an adequate work level performing dynamic exercise and the evaluation is facilitated by the absence of tachycardia and forced respiratory movement. Moreover, in contrast to the situation...
during exercise, the patient may be echocardiographically monitored during the entire procedure. Dipyridamole has been used for provocation of myocardial ischemia in patients with coronary artery disease [5-11]. However, an obvious disadvantage of dipyridamole is that it is an indirectly acting substance [12,13] and the half-life is relatively long, implying the need for an antidote to abort adverse reactions. The use of adenosine instead of dipyridamole for pharmacological induction of myocardial ischemia may increase the safety and efficacy of the test. Due to the short half-life of adenosine, titration to optimal dosage is possible and side effects will disappear within seconds after termination of administration [14]. The purpose of this study, therefore, was to compare the usefulness of adenosine provocation during electrocardiographic and echocardiographic monitoring with conventional exercise echocardiography; to determine sensitivity of adenosine echo test and to evaluate the safety and tolerability of the adenosine infusion.

Materials and methods

The study was performed using an open-label, cross-over design with provocation of myocardial ischemia at two different occasions within 24 hours using a) symptom limited dynamic stress test on a bicycle ergometer, and b) intravenous infusion of adenosine solution in the cubital vein.

Patients

31 men aged 59±7 years with clinical diagnosis of stable angina pectoris, positive exercise test and who were scheduled for coronary angiography, PTCA or coronary artery by-pass surgery were included in the study. Prior to inclusion all patients received full information of the aims and procedures of the study, which had been approved by the local Ethics Committee.

The patients were instructed to fast after midnight on the day prior to both tests and to avoid coffee and tea. Therapy with β-blockers and ACE-inhibitors were withdrawn at least 48 hours and calcium antagonists and long-acting nitrates at least 12 hours prior to the test.

Echocardiographic measurements

M-mode and two-dimensional echocardiograms were obtained using commercially available imaging systems with 2.5 or 3.5 MHz transducers. Chamber size, wall thickness and percent of fractional shortening were calculated in the standard manner from parasternal and apical views. Two- and four-chamber left ventricle planes were recorded on video tape and continuous loops were acquired. To detect and quantify left ventricular wall motion abnormalities and volume changes from baseline to stress, continuous loops were displayed in side-to-side format and analyzed by two independent observers, blinded of ECG results and coronary angiography data. Left ventricular volumes and ejection fraction were calculated using single plane ellipse formula.

Semiquantitative regional wall motion scoring system was estimated using 10 segments; 1: apical 2 chamber view; 2: anterolateral; 3: anterobasal; 4: diaphragmal; 5: posterobasal; 6: apical-4 chamber; 7: septal-distal; 8: septal-proximal; 9: posterolateral-distal and 10: posterolateral-basal. According to its regional wall motion and thickening, numerical score was given to each segment in a 4 grade scale; 1: normal or hyperkinetic – normal wall motion at baseline with progressive increase in wall motion as stress increased; 2: hypokinetic – less than 5mm of endocardial excursion from baseline with reduction or failure to increase wall motion from lower to higher stress; 3: akinetic – absence of visible inward motion and 4: dyskinetic – paradoxal wall motion away from center of left ventricle in systole (Fig. 1).

Left ventricular score index (LVSI) was defined as total score divided by number of analyzed segments. An increment of LVSI of 0.3 or more from baseline was considered as a positive test result.