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Original Article

Efficacy of post exercise pulsed wave tissue velocity imaging in diagnosing more than 70% coronary artery stenosis

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ABSTRACT

Background: To evaluate efficacy of post exercise tissue velocity imaging in diagnosing more than 70% coronary artery stenosis.

Method: Twenty patients with angiographically proved significant coronary artery disease and 26 healthy controls were evaluated. Pulsed wave tissue velocity imaging was performed at rest and immediately after treadmill stress test. Medial and lateral part of mitral annulus and medial and lateral part of tricuspid annulus were evaluated.

Result: No change or reduction in systolic annular velocity after exercise at any of the four sites identified patients of significant coronary artery disease with 75% sensitivity and 73% specificity. Rise in the ratio of early diastolic inflow velocity to the corresponding early diastolic annular velocity above the identified site-specific cut-off value had sensitivity of 85% but specificity of 34.6%. A combination of no change or decrease in late diastolic annular velocity and no change or decrease in systolic annular velocity at any of the four sites had sensitivity of 75% and specificity of 88.46%.

Conclusion: Post exercise tissue velocity imaging can provide a useful, objective parameter for detection of ischemic heart disease on stress testing.

1. Introduction

In a patient with suspected coronary artery disease, supportive evidence from non-invasive evaluation is required before subjecting the patient to coronary angiography. Exercise electrocardiography is the cheapest and widely available modality but it can be falsely positive or falsely negative. Echocardiographic evaluation of segmental wall motion abnormalities is subjective and operator dependent with significant interobserver varibility.[1] Further, wall motion abnormalities recover rapidly following cessation of physical exercise and it is practically difficult to correctly interpret motion abnormality of all segments before they start improving. Pulsed wave tissue velocity imaging is an easy, reliable, objective and reproducible method for evaluating myocardial systolic and diastolic velocities.[2] It is independent of heart rate and preload.[3] Annular motion can be recorded easily in immediate post exercise period.[4] Previous studies on tissue velocity imaging have mostly used dobutamine stress for echocardiographic evaluation.[5–9] Exercise stress is, however, more reliable and physiological than pharmacological stress.[10] Most of the previous studies have evaluated

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effect of stress on tissue velocities of mitral annulus only. Significant disease in right coronary artery may only effect movement of tricuspid annulus.[4,8] These cases are likely to be missed if tricuspid annulus is not analyzed and may contribute to low sensitivity of test. Further, previous studies have either included patients with prior myocardial infarction or have not performed angiographic correlation.[9,11] Effect of exercise on E/Ea ratio and myocardial performance index have also not been mentioned in previous studies. We performed detailed analysis of tissue velocities in healthy subjects and patients with coronary angiographically proved coronary artery disease with an aim to find out if post exercise tissue velocity imaging could identify significant coronary artery disease.

2. Material and methods

Project was approved by the ethical committee of the institution and was, therefore, performed in accordance with the ethical standards laid down in the 1964 declaration of the Helsinki and it's later amendments. All persons gave informed consent.

2.1. Subjects

More than 70% stenosis of any coronary artery or a major branch was taken as coronary artery disease (CAD). Angina and ST segment depression of $\geq$1 mm 80 msec after J point during treadmill stress test was taken as "positive for exercise induced ischemia". Persons without any history of cardiac or pulmonary disease, normal clinical examination, negative treadmill stress test at target heart rate and normal echocardiographic examination at rest were taken as control. Coronary angiography was not advised in the control group as it was not justified. Persons with history of effort angina, normal echocardiographic examination at rest, positive treadmill stress test and more than 70% stenosis on coronary angiogram were taken as "coronary artery disease group". Exact involvement of different vessels varied significant from patient to patient and no two patients had identical vascular involvement. However, all patients had more than one vessel disease with at least one vessel having more than 70% stenosis. Exclusion criteria included prior history of myocardial infarction, angioplasty or coronary artery bypass surgery, atrial fibrillation, poor acoustic window, regional wall motion abnormality at rest, systolic dysfunction at rest, congenital or valvular heart disease. Twenty six persons qualified for control group and 20 persons qualified for coronary artery disease group.

2.2. Medication

None of the control group was receiving any drug. In the CAD group, 5 patients were having mild hypertension but were not receiving any drug. Two of these 5 patients with mild hypertension were receiving oral anti-diabetics. No patients were receiving beta-blockers, calcium channel blockers, ACE inhibitors or Angiotensin receptor blockers.

2.3. Echocardiography

It was performed on Siemens' Acuson X 300 with phased array transducer of 2–4 MHz and facility for pulsed wave tissue velocity imaging. Patients were examined in left lateral position. Echocardiography was performed as per standard guidelines.[12] Pulsed wave tissue velocity imaging was performed following standard protocol[13] in apical four chamber view in end-expiration with low filter setting [50 MHz], a small sample volume and optimal gain. Medial mitral annulus (MMA), lateral mitral annulus (LMA), medial tricuspid annulus (MTA) and lateral tricuspid annulus (LTA) were analyzed in sequence. Average of three consecutive beats was used for analysis. Following parameters were analyzed.

- Peak systolic velocity (Sa)
- Peak early diastolic velocity (Ea)
- Peak late diastolic velocity (Aa)
- Isovolumic contraction time (IVCT)
- Ejection time (ET)
- Isovolumic relaxation time (IVRT)
- Total duration of systole
- Myocardial performance index (MPI)

2.4. Treadmill stress test

It was performed on Mortara instrument X-Scribe system using Bruce protocol. Attainment of target heart rate, appearance of classical angina with ST segment depression of $\geq$1 mm 80 msec after J point or fall in systolic blood pressure were taken as end points.

2.5. Post exercise echocardiography

Immediate post exercise tissue velocity imaging was performed in left lateral decubitus position. If Ea and Aa waves were fused, recording was delayed till the two waves just separated from each other. In all patients, recording of post exercise tissue Doppler imaging velocities was completed within 2–3 min of peak exercise.

2.6. Coronary angiography

It was performed at other centers within 15 days after the stress test.

2.7. Statistical analysis

Observations are presented as mean $\pm$ standard deviation. Two groups were compared using unpaired 't' test. P value of $\leq$0.05 was considered statistically significant. Pre and post exercise values were compared to find if any post exercise tissue velocity imaging value could identify patients with CAD. Sensitivity, specificity, positive and negative predictive values of a particular criterion to detect coronary artery disease were calculated.