Role of Exercise Echocardiography to Predict Coronary Artery Disease

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Abstract:
Background: Coronary artery disease (CAD) is predicted to be the most common cause of death globally. Early detection of coronary artery disease and adequate management can reduce CAD related morbidity and mortality. Various non-invasive procedures have been developed to diagnose CAD. Stress echocardiography, myocardial perfusion (SPECT) and cardiac MRI are accepted as useful tools for evaluation of inducible myocardial ischaemia in intermediate risk group patient documented by pre test probability. Among them exercise echocardiography is a remarkable physiological, safe, feasible and cost effective.

Objective: To see the role of exercise echocardiography to predict CAD.

Materials and methods: This cross sectional study was conducted in University Cardiac Center (UCC), BSMMU. This study include the patients who are appointed for exercise tolerance test (ETT). Echocardiographic wall motion study was recorded at rest and after peak exercise and analyzed to diagnosis the regional wall motion abnormality. Specific CAD was confirmed by coronary angiogram.

Results: A total of 40 patients were included in the study from the patients who are appointed for ETT. Patients diagnosed as CAD has the mean age of 50.6 ± 9.7 years and majority of the patients were male (72.5%). Sensitivity, specificity, positive predictive value and negative predictive value of exercise echocardiography were 85.5%, 76.9%, 88.5% and 71.4% respectively in predicting coronary artery disease by exercise echocardiography. The predominant risk factors was hypertension (40.0%) followed by diabetes mellitus, smoking, dyslipidaemia and family H/O CAD were significantly associated with the development of CAD in the study subjects.

Conclusion: Treadmill exercise stress echocardiography demonstrates high significance for diagnosis of CAD.

Keywords: Coronary artery disease, Inducible Myocardial Ischaemia, Exercise Stress Echocardiography, Exercise Tolerance Test.
The diagnostic specificity of exercise ECG and MPI is definitely lower in women due to hormonal influences for exercise testing and breast attenuation for nuclear technique. DSE is inferior to exercise for producing physiological stress. MPI is available in very few centres and are expensive. Exercise stress echocardiography provides similar diagnostic and prognostic accuracy as MPI or MRI but at a substantially lower cost, without environmental impact and no radiation hazards for the patient and the physician.

Treadmill exercise stress echocardiography have high significance for diagnosis of CAD with high negative predictive value, it can help deciding appropriate case selection for CAG.

Despite the validity of exercise echocardiography, exercise stress echocardiography have not reached a full blown status and not known to be used on a routine clinical basis and it has not been used widely in our country. The gap of knowledge of utility of exercise echocardiography should be filled with prospective studies to support more evidence based treatment strategies in our country.

Materials and Methods:
This study was conducted in the Department of Cardiology, BSMMU, DHAKA. Study period was from April 2019-September 2019. It was a cross sectional observational study. The study was carried out in patients who underwent exercise stress test for detection of inducible myocardial ischaemia.

Patients underwent exercise tolerance test (ETT) for detection of inducible myocardial ischemia and who were agreed to do CAG was included. Patients having structural heart disease, valvular heart disease, congenital heart disease, hypertrophic cardiomyopathy, old MI, left ventricular dysfunction (an ejection fraction <50%) and who can not perform treadmill exercise, having ETT contraindication and echocardiography window poor was excluded.

Selection of study population from those patients underwent ETT after meeting inclusion and exclusion criteria. At first resting echocardiography showed no regional wall motion abnormality, then treadmill ECG was done. Treadmill echocardiography and wall motion study was done in ETT positive patients within 1-1.5 minutes of peak exercise by expertise. Coronary angiography was done in echocardiography positive and negative patients.

Continuous variables was expressed as means ± SDs and categorical variables was expressed as percentages. Correlation of stress Echo findings with CAG findings was done. Concordance in coronary artery territory between induced ischemia during treadmill exercise stress echocardiography and coronary artery disease on coronary angiography was analyzed by two by two contingency table. A p<0.05 will be used to reject the null hypothesis. The statistical analysis will be performed using Statistical Package for the Social Sciences (SPSS) version 22 (SPSS Inc., Chicago, IL, USA).

Results:
More than half (52.5%) of the patients were upper middle aged or elderly (50 or >50 years old), 35% middle aged (41-50 years) & only 12.5% lower middle aged (<40 years). The mean age of the patients were 50.6 ± 9.7 years. Patients were predominantly male (72.5%) with male to female ratio roughly being 2.6:1. (Table I)

| Age (years) | Frequency (n) | Percentage |
|------------|---------------|------------|
| ≤40        | 5             | 12.5       |
| 41 – 50    | 14            | 35.0       |
| 51 – 60    | 14            | 35.0       |
| >60        | 7             | 17.5       |
| Male       | 28            | 72%        |
| Female     | 12            | 28%        |

Mean ± SD = 50.6 ± 9.7

There is no regional wall motion abnormality before exercise but after exercise wall motion abnormality present. As P value is <0.001, so the result is significant.(Table II)

| Pre and post exercise wall motion score and index (N=40) |
|---------------------------------------------------------|
| Pre | Post | p-value |
| Total wall motion score | 17.00 ± 0.00 | 22.47 ± 1.48 | <0.001 |
| Wall motion score index | 1.00 ± 0.00 | 1.32 ± 0.08 | <0.001 |

Highest proportion of inducible ischaemia was observed in RCA territory (65%), followed by LCX territory (35%) & LAD territory (25%). (Table III)

| Distribution of arterial territorial involvement in individuals with inducible myocardial ischaemia by exercise stress echocardiography (N=40). |
|---------------------------------------------------------|
| Inducible myocardial ischaemia | Frequency (n) | Percentage |
| LAD territory | 10 | 25.0 |
| RCA territory | 26 | 65.0 |
| LCX territory | 14 | 35.0 |
Sensitivity, specificity, positive predictive value & negative predictive value of exercise echocardiography were 85.2%, 76.9%, 88.5% & 71.4% respectively in predicting coronary artery disease. (Table IV)

| Exercise echo | CAG        | Total  |
|---------------|------------|--------|
|               | Positive   | Negative |
| Positive      | 23 (85.2)  | 3 (23.1) | 26 (65.0) |
| Negative      | 4 (14.8)   | 10 (76.9) | 14 (35.0) |
| Total         | 27 (100.0) | 13 (100.0) | 40 (100.0) |

N=number of study population

Validity test of exercise echo

|                      | %     |
|----------------------|-------|
| Sensitivity          | 85.2  |
| Specificity          | 76.9  |
| Positive predictive value | 88.5  |
| Negative predictive value | 71.4  |

Discussion:
In this study, the mean age of this study subjects was lower as compared with American and European studies. The highest proportion of patients were in the 4th and 5th decade in life. Increased occurrence of CAD in this age group may be explained by increased prevalence of diabetes, dyslipidaemia and family history of CAD in younger population in our country.

Study performed in Asian, American and European population , the mean age of CAD was 47.43 ± 9.58 years, 56 ± 10 years and 61.0 ±12.3 years respectively. The age variation for the development of CAD may be attributed to geographical variation and ethnic variation.

In this study, CAD occurred at a disproportionately high rate among male as compared with female. A study was performed showed 67.1% of them were male. Another study was performed showed 83.3% of them were male. However, the reason for male predominance in this study can be explained as females are reluctant to be treated due to socio-cultural and religious reason and oestrogen has got protective role for coronary artery disease in female.

In this study, sensitivity, specificity, positive predictive value and negative predictive value of exercise echo were 85.2%, 76.9%, 88.5% and 71.4% respectively in predicting coronary artery disease. This study results concurrent with the following study.

|                       | Kim et al. (2016) | Pasierski et al. (2001) | Kwok et al. (1999) | Armstrong et al. (1986) | Rayan et al. (1988) |
|-----------------------|-------------------|-------------------------|--------------------|-------------------------|---------------------|
| Sensitivity           | 70.4%             | 82.0%                   | 86.0%              | 64.0%                   | 78.0%               |
| Specificity           | 94.6%             | 96.0%                   | 96.0%              | 88.0%                   | 100.0%              |
| Positive predictive value | 88.5%        | 97.0%                   | 97.0%              | 87.0%                   | 85.0%               |
| Negative predictive value | 71.4%        | 79.0%                   | 79.0%              | 77.0%                   | 85.0%               |

Our study reveals sensitivity, specificity, positive predictive value and negative predictive value of exercise echocardiography in prediction of coronary disease of patients as a whole.

Conclusion:
A significant proportion of patients with chest pain have underlying inducible myocardial ischaemia as evident by Exercise Stress Echocardiography. It may be more helpful to predict coronary artery disease by exercise stress echocardiography.

Limitations:
1. Single centered study.
2. Potential selection bias because only patients with chest pain were selected, a significant number of patients were left out.
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3. The study followed a cross-sectional design, so the patients were not followed up for clinical and prognostic parameter.

Conflict of Interest:
Authors has no conflict of interest.

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