

POSITIVE PREDICTIVE VALUE OF EXERCISE TOLERANCE TEST IN PATIENTS; TAKING ANGIOGRAPHIC FINDINGS AS GOLD STANDARD

Shuja Abbas, Sarfaraz Ali Zahid, Zohair Aziz, Rehana Khadim, Qurrat-ul-Ain Zaidi*, Tariq Hussain Khattak*, Sohail Aziz*

Armed Forces Institute of Cardiology & National Institute of Heart Diseases Rawalpindi (AFIC/NIHD)/National University of Medical Sciences (NUMS) Rawalpindi Pakistan, *Pak Emirates Military Hospital/National University of Medical Sciences (NUMS) Rawalpindi Pakistan

ABSTRACT

Objective: To determine the accuracy of positive predictive value of Exercise Tolerance Test in patients; taking angiographic findings as gold standard.

Study Design: A descriptive cross-sectional study.

Place and Duration of Study: This study was conducted at outpatient department and coronary care units of Armed Forces Institute of Cardiology and National Institute of Heart Diseases, Rawalpindi from January 2018 till June 2018.

Material and Methods: Patients between the ages of 35-75 years of both genders presenting with positive ETT undergoing angiography were included in the study using consecutive sampling. Patients with previous MI, PCI or CABG, smokers with >5 pack years and alcohol drinkers were excluded from the study. Patients fulfilling selection criteria were enrolled through OPD after the informed consent. Angiographic findings were noted and labelled positive with vessel disease present. All the data was entered and analysed using SPSS version 21.

Results: Total 140 patients were included for the study. There were 85 (60.7%) male patients and 55 (39.2%) females. Mean age of the patients was 40.3 ± 15.6 years. About 44 (31.4%) patients were diabetic, 53 (37.8%) overweight/obese and 25 (17.8%) patients had family history of CAD. Mean duration of typical chest was reported to be 6.2 ± 0.5 months. All the patients were ETT positive and then underwent angiography. Out of all the ETT positive patients, 29 (27.6%) patients had single vessel disease, 31 (29.5%) double vessel disease and 60 (57.1%) patients had triple vessel disease on angiography. Positive predictive value of ETT was found to be 75%.

Conclusion: Our study results showed that exercise tolerance test has high positive predictive value. Thus ETT is recommended for the screening of coronary artery disease instead of going for angiography as coronary angiography is expensive procedure while ETT requires little intervention and expertise to diagnose coronary artery disease.

Keywords: Coronary artery disease, Coronary angiography, Exercise tolerance test, Positive predictive value.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Exercise is a physiologic stress that helps the physicians to clarify the presence or absence of cardiovascular disease which may be obscure at rest. Although it is sensitive, its specificity is affected by several parameters, such as some metabolic conditions, some structural heart diseases, and some baseline electrocardiogram abnormalities. Currently, the relationship between coronary dominance and accuracy of EET is not examined¹. The exercise treadmill test (ETT)

assesses for exercise induced myocardial ischemia and is commonly the first-line investigation in troponin-negative chest pain suspected of having coronary artery disease². Typical angina was defined as "the presence of substernal chest pain or discomfort that was provoked by exertion or emotional stress and was relieved by rest and/or nitroglycerin³." Ischemia was induced by stress testing in 14% of 231 patients with typical angina, 11% of 2140 patients with atypical chest pain, and 16% of 153 patients with no chest pain at presentation. Thus, patients with typical angina were not significantly more likely than those with no or atypical chest pain to have

Correspondence: Dr Shuja Abbas, Adult Cardiology, Armed Forces Institute of Cardiology Rawalpindi Pakistan
Email: shujaabbas3@gmail.com

inducible myocardial ischemia³. While ETT is widely available, its limitations are its moderate sensitivity and specificity. Abnormal ETTs that are falsely positive lead to unnecessary invasive coronary angiography⁴.

One study reported that positive predictive value of ETT was 77.9% in patients with typical chest pain undergoing angiography for positive ETT⁵. Another study also showed that positive predictive value of ETT was 77% in patients with typical chest pain undergoing angiography for positive ETT⁶. While another study showed high positive predictive value of ETT i.e. 85.1% in patients with typical chest pain undergoing angiography for positive ETT⁷.

The rationale of this study is to find the frequency of positive predictive value of ETT in young adults taking angiographic findings as gold standard. Literature has showed that in patients with positive ETT, positive predictive value is high. But varied data has been retrieved from literature. Moreover, there is little local data found in the literature and we are unable to recommend the screening of coronary artery disease on the basis of ETT instead of going for angiography. Coronary angiography is expensive, requires intervention and expertise to diagnose coronary artery disease. So we want to conduct this study to get the evidence to apply results of this study in local setting and implement ETT as first line diagnostic tool for detection of coronary artery disease instead of going for coronary angiography directly.

MATERIAL AND METHODS

This descriptive cross-sectional study was conducted at out patient department and coronary care units of Armed Forces Institute of Cardiology and National Institute of Heart Diseases, Rawalpindi from January 2018 till June 2018. Patients between the ages of 35-75 years of both gender presenting with positive ETT undergoing angiography were included in the study using consecutive sampling. Patients with previous MI, PCI or CABG, smokers with >5 pack years and alcohol drinkers were excluded

from the study. Patients fulfilling selection criteria were enrolled through OPD after the informed consent. Demographic details, diabetes history (BSR>186mg/dl) and duration of typical chest pain were noted. Then all the patients were admitted in wards and underwent coronary angiography. Angiographic findings were noted and labelled positive with vessel disease present. Positive ETT was defined as point that is 80ms from the J point (depression of 0.1 mV (1mm) or more and/or an ST-segment slope within the range of $\pm 1\text{mV/s}$ in 3 consecutive beats) in patients with typical chest pain (for >30minutes on

Table: Showing demographic and clinical details of patients.

Parameters	n(%)
Age (mean \pm S.D)	40.3 \pm 15.6 years
Gender	
Male	85 (60.7%)
Female	55 (39.2%)
Diabetes Mellitus	44 (31.4%)
Hypertension	53 (37.8%)
Family History of CAD	25 (17.8%)
Body Mass Index	
Normal BMI	87 (62.1%)
Overweight/Obese	53 (37.8%)
Duration of Chest Pain (mean \pm S.D)	6.2 \pm 0.5 months
Type of Typical Chest Pain	
Unstable Angina	99 (70.7)
Stable Angina	41 (29.2%)
Culprit Vessel	
LMS	1 (0.7%)
LAD	77 (55.2%)
LCX	21 (15.6%)
RCA	41 (29.2%)

rest). Angiographic findings was labelled if there was >50% stenosis in any coronary artery. Positive predictive value was labeled if there was >50% stenosis in at least one coronary artery (SVD, DVD or TVD) on coronary angiography already diagnosed as positive on ETT. All the data was entered and analysed using SPSS version 21.

RESULTS

Total 140 patients were included for the study. There were 85 (60.7%) male patients and

55 (39.2%) females. Mean age of the patients was 40.3 ± 15.6 years. 44 (31.4%) patients were diabetic, 53 (37.8%) overweight/obese and 25 (17.8%) patients had family history of CAD. Mean duration of typical chest was reported to be 6.2 ± 0.5 months. All the patients were ETT positive and then underwent angiography as summarized in table.

Out of all the EET positive patients, 29 (27.6%) patients had single vessel disease, 31 (29.5%) double vessel disease and 60 (57.1%) patients had triple vessel disease on angiography as shown in figure.

Positive Predictive Value, $PPV = \frac{\text{True Positives}}{\text{True Positives} + \text{False Positives}}$

True Positives + False Positives

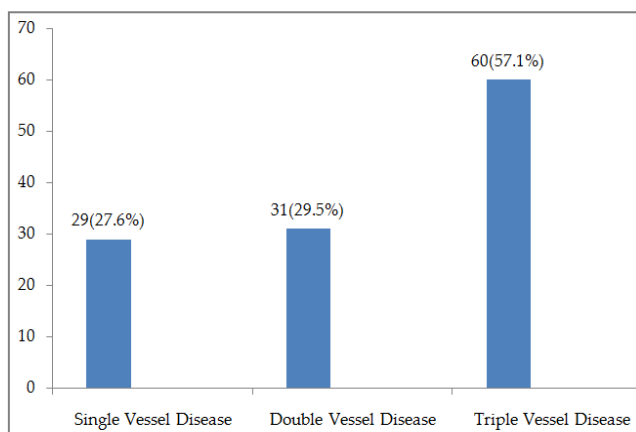


Figure: Angiographic findings of patients.

Positive Predictive Value, $PPV = \frac{29+31+60}{105+35}$

Positive Predictive Value, $PPV = 75$

Positive predictive value of ETT was found to be 75.

DISCUSSION

Exercise tolerance test has played a central role in the diagnostic workup of CAD for almost a century⁸. But because of the limited sensitivity and specificity of the test, other expensive investigations are being increasingly used in our country⁹. The ETT is still the least costly of all other non-invasive tests currently available. The

diagnostic accuracy of the treadmill test can be improved by identifying the factors which can cause false positive test results. In this study six months data of patients undergoing ETT for chest pain diagnosis followed by coronary angiography if test result turned out to be positive has been presented. The current study showed a higher percentage of true positive results among patients 105 (75%). This finding is consistent with other studies which showed high sensitivity of this test¹⁰. Many investigators have attempted to improve the diagnostic accuracy of treadmill testing in women by creating new variables such as ST/Heart rate slope, computer generated algorithms and gender specific guidelines for interpretation¹¹⁻¹³. Other investigators have suggested that initial testing strategies should be stress imaging rather than treadmill testing^{10,12}. But the Duke Treadmill Score improves the diagnostic accuracy of ETT¹⁴. It was noticed that changes in the resting ECG like ST-segment depression or T wave inversion also affect the test result. William *et al* have shown in their study that the specificity of the ETT decreases with resting ST-segment depression ($48 \pm 12\%$ versus $84 \pm 3\%$)¹⁵, because of inclusion of more false positive test results severe systemic hypertension may interfere with the subendocardial perfusion and may lead to ST-segment depression even in the absence of atherosclerosis, thus resulting in false positive test results¹⁵. In the current study chest pain was observed more frequently in the true positive group and asymptomatic. Exercise induced chest discomfort without associated ECG changes maybe the only signal that obstructive coronary artery disease is present¹⁶. Early onset of angina is an important parameter of adverse prognosis. Strongly positive ETT was more commonly noted in the true positive group, this has been reported by other studies as well¹⁷. Fletcher *et al* have reported that the patients who have strongly positive ETT show adverse prognosis and a multi vessel coronary artery disease¹⁸. In patients with single vessel disease in our study, the sensitivity was of ETT is 27.6%, whereas it is 57.1% in

patients with triple vessel CAD. It was also observed that the most frequent coronary artery involved was LAD followed by RCA and than LCX. This has been reported previously by other investigators as well^{1,6,12}. Our study had few limitations, i.e., the study population was very small. As coronary angiography is an invasive procedure and the patients who were not symptomatic should not be urged to go for the angiography.

CONCLUSION

Our study results showed that exercise tolerance test has high positive predictive value. Thus ETT is recommended for the screening of coronary artery disease instead of going for angiography as coronary angiography is expensive procedure while ETT requires little intervention and expertise to diagnose coronary artery disease.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

REFERENCES

- Attar A, Mehrzadeh A, Foulad M, Aldavood D, Fallahzadeh MA, Rad MA, et al. Accuracy of exercise tolerance test in the diagnosis of coronary artery disease in patients with left dominant coronary circulation. *Ind Heart J* 2017; 69(5): 624-7.
- Lau GT, Wei H, Wickham J, To AC. The significance of equivocal exercise treadmill ECG for intermediate risk chest pain assessment—Insight from coronary CT angiography data. *Heart, Lung and Circulation* 2018; 27(1): 50-7.
- Hermann LK, Weingart SD, Yoon YM, Genes NG, Nelson BP, Shearer PL, et al. Comparison of frequency of inducible myocardial ischemia in patients presenting to emergency department with typical versus atypical or nonanginal chest pain. *Am J Cardiol* 2010; 105(11): 1561-4.
- Gueret P, Deux J-F, Bonello L, Sarran A, Tron C, Christiaens L, et al. Diagnostic performance of computed tomography coronary angiography (from the Prospective National Multicenter Multi-vendor EVASCAN Study). *Am J Cardiol* 2013; 111(4): 471-8.
- Taimur SDM, Khan SR, Islam F. Angiographic Evaluation of ETT (Treadmill) Positive Patients in a Tertiary Care Hospital of Bangladesh. *Int J Med Health Sci* 2014; 8(12): 851-4.
- Gheydari ME, Jamali M, Hajsheikhholeslami F, Yazdani S, Jamali M. Value of exercise tolerance testing in evaluation of diabetic patients presented with atypical chest discomfort. *Int J Endocrinol Metabol* 2013; 11(1): 11.
- Faisal A, Abid AR, Azhar M. Exercise Tolerance Test: a comparison between true positive and false positive test results. *J Ayub Med Coll Abbottabad* 2007; 19(4): 71-4.
- Chaitman BR. Exercise stress testing. In: Bonow R.O., editor. *Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine*. 9th ed. Saunders; Philadelphia: 2012. pp. 168-99.
- Banerjee A, Newman DR, Van den Bruel A, Heneghan C. Diagnostic accuracy of exercise stress testing for coronary artery disease: a systematic review and meta-analysis of prospective studies. *Int J Clin Pract* 2012; 66: 477-92.
- Khan AR, Khan Luni F, Bavishi C, Khan S, Eltahawy EA. Left dominant circulation increases mortality in acute coronary syndrome: a systematic review and meta-analysis of observational studies involving 255,718 patients. *Catheter Cardiovasc Interv* 2016; 88: 201-208.
- Nepal R, Murti AO, Sayami A. Association between cardiac syndrome X and non-dominant right coronary artery. *J Clin Prev Cardiol* 2015; 4(3): 54-57.
- Makarovic Z, Makarovic S, Billic-Curcic I. Sex- dependent association between coronary vessel dominance and cardiac syndrome X: a case-control study. *BMC Cardiovasc Disord* 2014; 14: 142.
- Gupta T, Saini A, Sahni D. Terminal branching pattern of the right coronary artery in left-dominant hearts: a cadaveric study. *Cardiovasc Pathol* 2013; 22: 179-82.
- Attar A, Rezaee M, Kheirkhah J. Left ventricular dysfunction: Neither a matter of atherosclerosis nor an anomalous originated right coronary artery from left anterior descending artery. *ARYA Atheroscler* 2015; 11: 252-255.
- Williams MJ, Marwick TH, O'Gorman D, Foale RA. Comparison of exercise echocardiography with an exercise score to diagnose coronary artery disease in women. *Am J Cardiol* 1994; 74: 435-8.
- Habeeb QS. Reliability and accuracy of exercise tolerance test in the diagnosis of coronary heart disease. *Dohuk Med J*. 2007;1:98-104.
- Chaitman B.R. Exercise stress testing. In: Bonow RO, editor. *Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine*. 9th ed. Saunders; Philadelphia: 2012. pp. 168-99.
- Fletcher GF, Balady GJ, Amsterdam EA, Chaitman B, EckelR, Fleg J, et al. Exercise standards for testing and training: A statement for health care professionals from the American Heart Association. *Circulation* 2001; 104: 1694-740.