

Study of Effect of exercise on left ventricle diastolic function in normal subjects

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ABSTRACT:

Background: Determining the factors affecting exercise capacity is extremely significant because it can improve the life span and the quality of life of subject as exercise capacity is related to prognosis in healthy people and in heart disease patients.

Objective: To determine the effect of cardiac diastolic function assessed by echocardiography on exercise capacity

Methodology: The Study was conducted on 100 subjects at Haldiram and Moolchand Heart Centre, PBM Hospital, S.P. Medical College, Bikaner. First a resting echocardiography was performed to evaluate cardiac diastolic function. After echocardiography the subjects were underwent Bruce protocol treadmill test.

Result & Conclusion: There exists a strong association among VO_{2max} and diastolic function as observed by E/A and A's positive correlation with VO_{2max} and negative correlation of diastolic function indices E, E/E', LAVI with VO_{2max}

Key words: Exercise, Echocardiography, treadmill test

INTRODUCTION:

Exercise is considered as a stressful situation that results in evident variations in functions of body especially nervous, respiratory and cardiopulmonary activities. Exercise is thus considered to be a way for discovering an individual's physiological responses and physical capabilities.(1)

Exercise capacity is described by way of "the maximum oxygen uptake for a given workload" as well as thus, expressed either as VO_2 max (the greatest rate of oxygen uptake during exercise as well as used by the body) or METS (metabolic equivalent or oxygen consumption's basal rate's multiples while a person being at rest that is for an average adult 3.5 ml/kg/min).(2)

Doppler echocardiography is also able to describe the left ventricular functions by means of a variety of measures that suggest irregular left ventricular filling, greater left ventricular rigidity or impaired ventricular relaxation. Echocardiography by Doppler can also approximate left ventricular pressure, which is a diastolic function representing pulmonary capillary wedge in pressure. Such parameter were presented to align with exercise capacity in previous studies.(3,4,5) Whether diastolic dysfunction describe differences in exercise capacities is still unclear.

MATERIAL AND METHOD:

This Cross sectional study was conducted at Haldiram and Moolchand Heart Centre, PBM Hospital, S.P. Medical College, Bikaner, Rajasthan, India from 1 August 2017 to 1 August 2018. Study on 100 participants.

Demographic characteristics of all participants were taken including weight, height, age etc.

BMI was calculated by using formula. $(\text{BMI} = \text{weight (kg)} / \text{height (m)}^2)$

Left ventricular Systolic function was assayed by 2D echocardiography and followed by treadmill test by Bruce protocol of all participants.

Exclusion criteria : participants having atrial fibrillation/flutter at the time of exercise; had moderate or severe valvular heart disease; had poor image quality, which prohibited a final impression; had ejection fractions of less than 50%; or had echocardiographic evidence of exercise induced myocardial ischemia; any respiratory disease; suffering from any chronic or acute disease; taking any drugs that could affect the heart .

Evaluation of cardiastolic function

Apical 4-chamber view is used for obtaining Doppler transmitral inflow with 3.5 MHz frequency and sweep time 2-12 seconds. The following parameters were calculated.

1. The ratio E/e' , a left ventricular filling pressures measurement, was possible in every patient which are at rest.

2. Left atrial size's 2-dimensional measurement.

3. The baseline resting assessment includes late (A) and early (E) mitral inflow velocities' pulsed-wave Doppler measurements

Resting diastolic function was categorized as severe dysfunction (restrictive), moderate dysfunction (pseudonormal), mild dysfunction (impaired relaxation), or normal.(6)

The different grades of diastolic functions were classified according to below given criteria:

Variable	Normal	Grade I (Mild)	Grade II (Moderate +Severe)
E/e'	<10	<10	>10
E/A	>0.75	<0.75	0.75 – 1.5
LAVI	<28	<28	>28

Tread mill exercise test : The Bruce protocol (Bruce RA., 1972) multistage treadmill testing of maximal exercise was used(7). Resting ECG, pulse rate and blood pressure was measured. Subject was explained and demonstrated the procedure and instructed to inform immediately if anything happens or any problem occurs. VO_2 max was calculated by following formula. VO_2 max in male = $14.8 - (1.379 \times T) + (0.451 \times T^2) - (0.012 \times T^3)$ VO_2 max in women = $4.38 \times T - 3.9$ ("T" is the total time on treadmill measured as fraction of minutes).

RESULT:

Mean value of basal echocardiographic characteristics $E/A, E/E, LAVI, EDD$ was observed as per Table 1

Table 1: Baseline Echocardiography Characteristics

Variables	Normal n = 50	Mild n = 25	Moderate n = 25
E/A, mean (SD)	1.2 (0.3)	0.67 (0.06)	1.2 (0.19)

E/e', mean (SD)	7.3 (1.7)	6.5 (1.65)	11.0 (1.05)
LAVI, mean (SD)	14.9 (3.00)	15.2 (3.08)	28.6 (0.57)
EDD, mean (SD)	4.2 (0.28)	4.0 (0.24)	4.2 (0.22)

The comparison of echocardiography characteristics among normal function, mild diastolic dysfunction and moderate diastolic dysfunction using examination of variance test using Tukey honestly significant difference * $p < 0.05$ compared to patients with normal diastolic function was done as per Table 2

Table 2 : Analysis of echocardiographic variables of different grades of diastolic function with exercise capacity

Resting variables	Mean±SD		P value
Mild diastolic dysfunction vs normal function	Mild 22.7±4.6.	Normal 30.8±5.3	P<0.001
Moderate diastolic dysfunction vs normal function	Moderate 23.6± 2.1	Normal 31.9±5.7	P<0.001
Resting E/e' ≥ 10	E/e' > 10 24.4±3.3	E/e' < 10 28 .0± 6.4	P<0.001
Left atrial volume index > 28 ml/m ²	Lavi > 28 23.6± 2.1	Lavi < 28 28.1±6.4	P<0.001

DISCUSSION:

Normal diastolic function was observed in 50% of the individuals; 25% showed mild diastolic dysfunction; 25% showed moderate diastolic dysfunction. In our study, diastolic dysfunction was strongly and inversely associated with exercise capacity similar to Grewal et al (8) . Compared with normal function those with moderate/severe and mild resting diastolic dysfunction had substantially lower exercise capacity. Matsumura Y et al (2002) and Kim HK et al (2003) suggested a strong correlation between mitral-annulus Doppler tissue and exercise capacity has been seen in several studies possibly because of the interaction of the E/E ratio with associated ventricular-filling pressures.(9,10)

Left ventricular filling pressures measured by resting E/e' > 10 was also associated with a reduction in exercise capacity. Grewal et al also observed a good correlation between the E/e' ratio and exercise capacity in a population at a moderate cardiovascular risk.

Resting exercise E/e' ≥ 10 was associated with a -3.6(3.1) reduction in exercise capacity (p<0.001) compared with E/e' of <10. Left atrial volume index ≥ 28 was associated with a -4.5(4.3) reduction in exercise capacity (p < 0.001) as compared to left atrial volume <28. Also, left atrial pressure must increase to a level that creates a pressure gradient large enough to

provide adequate ventricular filling during exercise in the setting of impaired left ventricular relaxation.

The abnormality in diastolic function decreases exercise capacity because rise in cardiac output during exercise depends on the diastolic filling. During exercise due to increase in heart rate, the diastole is shortened and if diastole is accompanied by left ventricular relaxation and filling abnormalities, the lowest filling rates are achieved and become inadequate to supply the cardiac output required during exercise, with a subsequent increase in filling pressures and decrease in the maximal capacity.(11) The more abnormal the baseline diastolic function, the lower the exercise capacity.

CONCLUSION:

Our study indicates that there exists a strong association among VO_{2max} and diastolic function as observed by E/A and A's positive correlation with VO_{2max} and negative correlation of diastolic function indices E, E/E', LAVI with VO_{2max} . Before regulating for other echocardiography factors, the moderate and mild diastolic dysfunction presence is related to decrease in VO_{2max} respectively as compared to normal diastolic function.

Life expectancy is growing, resulting increased age is related to independence loss and growing disabilities. With increasing age, it is common to have the chronic conditions. Maintaining cardiovascular fitness will not only help in increasing longevity and reducing premature death but, more significantly, it might reduce the illness period so that until near death people will be healthy.

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