

Effect of maximal exercise testing on ankle brachial index among normal and obese asymptomatic adults

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Abstract

Background: Peripheral arterial disease is associated with high mortality secondary to cardiovascular events. ABI is an easy and cost efficient method to check for PAD. ABI has been used to predict adverse cardiovascular events individualistic of the conventional CV risk factors and mortality rate. Obesity usually is observed in PAD patients, as obese individuals present a rise in workload at the time of physical activity, leading to reduce walking capacity and low exercise tolerance.

Objective: To evaluate the effect of maximal exercise testing on cardio respiratory fitness among normal, overweight and obese asymptomatic adults.

Method: 60 Asymptomatic adults of different BMI, were divided in 4 groups (15 in each group) according to their BMI by using Stratified random sampling. Participants who were asymptomatic were included in the study. The participants were made to perform 20m multistage fitness stage test, prior to the test vitals were checked and noted, post test immediately vitals were taken and ABI and VO₂max were noted.

Result: ABI and VO₂ max in group D was slightly reduced post testing as compared to the other groups. Significant differences were seen in between group B and D.

Conclusion: Maximal exercise testing can be used as a simple procedure to identify individuals who are asymptomatic of any symptoms of PAD at rest and have a normal ABI at rest, irrespective of the BMI.

Keywords: ABI, PAD, obesity.

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1. Introduction

The ankle brachial index (ABI) as know as ankle-brachial blood pressure index also the Winsor index; it is the relation of the systolic pressure of the ankle to brachial artery. The term ABI was recommended on Artherosclerotic Pheripheral Vascular Disease by the recent American Heart Association.[1] ABI has been used to predict adverse cardiovascular events individualistic of the conventional CV risk factors and mortality rate.. The main cardiovascular societies suggest checking ABI in adults above 50 years of

age, every diabetic adult over 50 years of age and all elderly over 70 years of age.

The systolic blood pressure is recorded with a handheld Doppler instrument (5-10 MHz). The brachial pulse is measured in the cubital fosse on the patient's brachial pulse and for the ankle pulse, it is measured on the posteriortibial (PT) arteries and dorsalispedis (DP) artery in the ankle. Using a calibrated hand held Doppler head and ultrasound gel, check for the signal.

The ABI is calculated by:

$$ABI = \frac{\text{systolic pressure in foot}}{\text{systolic pressure in arm}}$$

The ABI normal ranges from 0.9-1.4. values that are below 0.9 are considered diagnostic of PDA. Values that are more than 1.4 suggest of calcified vessels, among elderly patients and in diabetic patients, the limb vessels are calcified or fibrotic.[1]

ABI at rest may be affected due to various physiological factors such as Gender, age, weight, height. There is arterial stiffening due to aging which increases the ABI. In taller people they may have a higher ABI than short height individuals, as a result of the escalating SBP rises with more distance from the heart.[1]

In healthy individuals, there must a less than 10mm Hg systolic pressure gradient in between the arms during a regular check-up. Greater than 10mm Hg difference between the arms is suggestive of axillary or subclavian arterial stenosis, which is seen in individuals at a risk of atherosclerosis.[2]

The ABI is a handy tool for, specific, cost-effective, non- invasive diagnosis for peripheral artery disease (PAD). 8% to 22% of individuals above 55 year are presented with PAD; from which 10% have the usual sign and symptoms of intermittent claudication, among which 50% present symptoms in leg and the other 40% have no symptoms.[3]

1.2 maximal exercise testing

Maximal exercise testing is possibly the most challenging assessment test of all the physical fitness testing. Maximal exercise testing is as know a graded exercise testing, as they are graded by increasing the workload progressively for the individual. VO_2 peak is the value achieved highest at the time of exercise which means an individual's exercise tolerance; whereas, VO_2 Max shows the highest physiologically achieved value. A VO_2 Max is at peak but a VO_2 peak is not maximal always. The variation between VO_2 Max and VO_2 peak is seen in the presence of a VO_2 plateau.[6] Graded or maximal exercise testing is used to note the potent relation between exercise workload and the combine cardio-pulmonary, musculoskeletal systems.

The presence of PAD measuring ABI non invasively is predictor of coronary artery disease (CAD) and of coronary events. However, standardized measurements for ABI have been measured at rest and might miscalculate the true presence of PAD.[8] As a direct correlation is present between the supply of blood flow to the working muscles and both the workload performance and the pressure drop through stenosis, it is not astonishing that moderate stenosis may be accountable for circulatory problems at the time of maximal or sub maximal exercise in

athletes, maybe it may remain asymptomatic in sedentary individuals. However, there is an increase in blood flow with physical activity, the ABI reduces in individuals with lower limb arterial disease, but also a physiological reduction in ABI may be seen at the time of exercise in normal individuals and an inverse relation directly exists between ABI and the workload.[9]

Sever obesity is related with both functional and structural impairment to the pulmonary and cardiovascular system and decreases oxidative capacity in skeletal muscles. Because of these physiologic variations, an individualistic predictor of cardiovascular disease risk is considerable reduced in various obese individuals. Hence, interventions targeting severe obesity must seek to increase the CRF in inclusion to reduce body weight. [10] The increase in the prevalence of obesity has a great impact on public health because obesity individually is a risk factor for cardiovascular and metabolic disease. Obesity is also frequently related with vasodilatory dysfunctions, which might reduce blood flow supply while or after exercise. [11]

1.3 20M Multistage Fitness Test (Beep Test)

The 20m multistage fitness test (MSFT) is frequently used as a maximal running aerobic fitness test. It is also called the 20 meter shuttle run test, beep or beep test. In this test it requires to run continuously between the two cones kept 20 meters apart in the time according to the beeps. Hence it is also known as the beep or beep test. The participant stands behind the cone A facing cone B, and starts running when instructed. The speed in between the beeps is initially slow. The participants run continuously between the cones according to the beeps. This is continued for 21 levels, which each level the duration reduces and the speed increase. Daniel Mayorga-Vega conducted a study in which he stated that the entire result conveyed that the score of the performance in the 20m shuttle run test had a moderate – high scale, associated validity for maximum oxygen uptake, which was higher than the other variables like age, sex or BMI. It also showed that statistically it is higher for adults as compared to children.[12]

2. Method

Ethical clearance was obtained by the Institutional ethical committee. A screening of 210 people was done in the medical and physiotherapy OPD between the age group of 20-40 years to identify individuals with normal BMI, over-weight and obese class I and II, who were then divided into different groups according to their BMI by doing stratified random sampling. 60 asymptomatic (15 in each group) adults were taken from the random sampling who were fitting in the inclusion criteria for the study. The inclusion criteria were:

- Age group 20-40

- ABI normal at rest
- The exclusion criteria were-
- COPD, asthma
- HTN
- DM
- Recent lower limb fracture
- Neurological disorders

The participants were then called for the test. A 20m multistage fitness test was performed by each participant. The test was terminated if the participant was voluntarily exhausted, had got two warning consecutively and the test had to be stopped. After the completion of the test, Heart rate, blood pressure, VO₂ Max and ankle brachial index were taken.



Figure 1: Checking BP on brachial artery with doppler



Figure 2: Checking BP on dorsalis pedis artery with doppler

2.1 Statistical analysis

The data analysis was done by using primer software. As the data was not normally distributed Wilcoxon rank test was used to compare pre and post values within the group. Whereas kruskal Wallis test was used to compare the pre and post values among all the four groups.

3. Observations and Results

3.1 Heart rate

Table 2: Pre and post data of heart rate

Heart rate mean value	Group A	Group B	Group C	Group D
Pre	85.87	86.27	81.07	86
Post	103.1	110.1	93.4	100.5
P value	<0.000	<0.000	<0.011	<0.000

3.2 VO₂ Max post maximal testing

Table 3: VO₂ Max post shuttle run test

VO ₂ Max	Group A	Group B	Group C	Group D
Post testing	25.82	25.61	24.97	22.49

3.3 Ankle Brachial Index (ABI)

Table 4: Pre and post ABI of all the groups

ABI mean value	Group A	Group B	Group C	Group D
Pre	1.002	1.007	1.008	1.006
Post	1.017	1.023	1.021	1.001
P Value	<0.003	<0.006	<0.002	<0.0464
% Difference	1.49%	1.58%	1.28%	-0.05%

Table 1 shows the mean value i.e., 1.002 and 1.017 for group A, 1.007 and 1.023 for group B; 1.008 and 1.021 for group C and 1.006 and 1.001 for group D, of ABI pre and post exercising testing. The p value is <0.003 for group A, < 0.006 for group B, < 0.002 for group C and <0.0464 for group D which is statistically significant.

Table 2 shows the mean value i.e., 85.87 and 103.1 for group A, 86.27 and 110.1 for group B; 81.07 and 93.4 for group C and 86 and 100.5 of group D, of Heart rate pre and post exercising testing. The p value is < 0.000 for group A, < 0.000 for group B, <0.011 for group C and <0.000 for group D which is statistically significant.

Table 3 shows the mean value i.e., 25.82 for group a, 25.61 for group B; 24.97 for group C and 22.49 for group D, of VO₂ max post exercising testing. The p value is <0.000 for all the groups which is statistically significant.

4. Discussion

The current study was carried out to investigate the effect of maximal exercise testing on ankle brachial index in normal and obese asymptomatic patients. The shuttle run test was used as a maximal exercise test to check the effect on ankle brachial index post maximal testing among normal, overweight and obese individuals.

For the study a total of 210 individuals were screened in, out of which 60 individuals were selected for the study that were fitting into the inclusion criteria of the study and by taking their consent to participate in the study. The subjects were divided in 4 different groups (A, B, C, D), according to their BMI; i.e., Normal class, over-weight,

obese class I, obese class II by using stratified random sampling. The mean BMI for normal group A was 21.37 for over-weight group B was 27.19, for group C i.e. obese class I was 31.15 and for class II obese group D was 37.48. The individuals were from the age group of 20-40 who were asymptomatic.

In the current study the heart rate has increased significantly in all the four groups post maximal exercise testing. The p value for group A and group B were 0.000, group C was 0.011 and that of group D is 0.000 which are all statically significant.

The increase in heart rate is due to an increase in cardiac output causes a rise in the systolic blood pressure with an increasing amount of working. The blood flow speeds up through the vascular system with an increase in blood pressure. Blood pressure helps determine the amount of blood leaving the capillaries into the tissue and supplies the required materials to it; as the autonomic nerves system is working during the time of exercise, this leads to varied cardiovascular system reactions like increase cardiac output. Possibly, after completion of exercise autonomic nervous system reduces the cardiovascular reactions and thus reduces the cardiac output, the process with which the active and passive recovery can accelerate. [14]

VO₂ max was found out by doing the 20 meters multi-stage shuttle run test, the p value for all the four groups was 0.000 which is statically significant. It was observed that the highest mean of VO₂ max was seen in group A i.e. individuals with normal BMI and was lowest in group D i.e. obese class 2 individuals.

The result of the current study shows that the mean ankle brachial index in group A per was 1.002, which ranged between 1-1.03 which are in the normal range for the ABI pre testing; post test the mean ABI is 1.017, which range between 1-1.04 which are in normal range of ABI with a p value of 0.003 which is statically significant. For Group B per was 1.007, which ranged between 0.97-1.04 which are in the normal range for the ABI pre testing; post attest the mean ABI was 1.023, which range between 1-1.04 which are in normal range of ABI with a p value of 0.006 which is statically significant. Similarly for group per value was 1.008, which ranged between 1-1.02 which is in the normal range for the ABI pre testing; post test the mean ABI was 1.021, which range between 1-1.03 which are in the normal range of ABI with a p value of 0.002 which is statically significant. As for group D obese class 2 individuals per value was 1.006, which ranged between 1-1.02 which are in the normal range for the ABI pre testing; post test the mean ABI was 1.001; which is slightly reduced as compared to the other groups, it range between 0.95-1.03 which are in normal range of ABI with a p value of 0.000 which is statically significant

During exercise, the diastolic blood pressure doesn't significantly changes, it is less influenced by exercise and environmental factors, and even a small change is dangerous for body system; because most of the cardiac cycles associated with diastolic blood pressure, which relates to when the heart is resting. Diastolic BP reduction during physical activity causes draining of the left ventricle into the aorta (after load reduction) completely, which lead to decrease in myocardial oxygen consumption and increased cardiac output. During physical activities there is an increase in the intrathoracic pressure and reduces venous return to the heart, the assembled blood in the circulation and thereby increases systolic blood pressure. During physical activities the body requires blood urgently, this causes a rise in systolic blood pressure and cardiac output to satisfy the active muscle requirement and a decrease in the oxygen consumption of heart muscles.[14] Post exercise abnormal ABI testing is related with increase in prevalence of revascularization in lower limb among people with abnormal and normal ABI at rest. Tarek A. Hammad *et al* found that, when compared individuals with resting and post exercise normal ABI, with subjects of both abnormal ABI at rest and post exercises have a tendency towards greater all cause mortality, and also a remarkable rise in the rate of utmost cardiovascular outcomes.⁽¹⁶⁾ A study on the effect of post exercise ABI in primary care outpatients setting they observed that patients who have ABI normal at rest but post exercise ABI were abnormal were at a greater risk of lower extremity revascularization and major adverse cardiovascular events but with no dissimilarity in overall mortality.[16]

5. Conclusion

ABI at rest for all the individuals had fallen under the normal range of ABI, but post exercise testing it showed a change of 1.4-1.5% of difference in all the groups expect in class II obese individuals a negative difference of 0.05 which may be negligible but may have chance of having PAD in the future. So, maximal exercise testing can be used as a simple procedure to identify individuals who are asymptomatic of any symptoms of PVD at rest and have a normal ABI at rest, irrespective of the BMI. This testing can be performed in a limited sitting area and provides objective assessment. Those who were observed to have a higher or borderline ABI could go onto further investigation for confirmatory diagnosis.

Future scope

To identify the changes in ABI post maximal exercise testing in Class I, Class II and class III Obese individuals have the prevalence of PAD.

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