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The Effect of Body Mass Index on Blood Pressure Response During Exercise Treadmill Test

Guliz ERDEM YAZICI*, Gulten TACOY, Buket ALIBAZOGLU

* Cardiology Department - Kırıkkale Yuksek Ihtisas Hospital, Kırıkkale, TURKEY
** Gazi University Faculty of Medicine Cardiology Department Ankara, TURKEY
*** Nucleer Medicine , Cardiocheck, Ankara, TURKEY

Abstract

Objectıve: To evaluate the effect of Body Mass Index (BMI) on arterial blood pressure response in patients undergoing stress exercise testing.
Methods: 168 patients who had normal myocardial perfusion scintigraphy were enrolled into this retrospective study and they were divided into 3 groups according to BMI: 18,5- 24,9 (normal, group 1), between 25-29.9 (over weight-preobese, group 2), between 30-39 (obese, group 3). Systolic blood pressure (BP) and diastolic BP at the 1st , 3rd and 6th minutes during the exercise stress test were measured. Clinical characteristics and antropometric measurements of the patients were recorded
Results : Both SBP and DBP of all groups showed significant increase with exercise ($p<0,01$). When SBP and DBP average values at the 1st , 3rd and 6th minutes were taken into consideration, the difference among 3 groups were found to be significant except the 6th minute DBP values ($p<0001$). The average percentages of systolic and diastolic blood pressure change at 3rd minute with regard to 1st minute weren't different statistically (p=0,454 and p=0,196 respectively).The average percentages of SBP increase at 6th minute with regard to beginning weren't different also (p= 0,109).
Conclusıon: Absence of this difference during exercise for obese people, implies that obesity didn't disturb the physiological response to the exercise.
Key words: Body Mass Index (BMI), blood pressure, exercise

Vücut Kitle İndeksinin Egzersiz Testi Sırasındaki Kan Basıncı Yanıtına EtkisiÖzet

Amaç: Egzersiz sırasında, vücut kitle indeksinin (VKI) arteryel kan basıncına etkisinin efor testi yapılan hastalarda değerlendirilmesidir.
Yöntem: Bu retrospektif çalışmaya miyokard perfüzyon sintigrafisi normal olan 168 hasta alındı. Hastalar VKI'lerine göre 3 gruba ayrıldı; 18,5-24,9 (normal, grup 1), 25-29,9 (preobez, grup 2), 30-39 (obez, grup 3). Egzersiz stres testinin 1., 3. ve 6. dakikalarında sistolik (SKB) ve diastolik kan basıncı (DKB) değerleri ölçüldü. Klinik özellikler ve antropometrik ölçümler kaydedildi.
Bulgular: Tüm grubun hem SKB ve DKB değerleri egzersiz ile birlikte anlamlı artış gösterdi ($p<0,01$). Birinci, 3. ve 6. dakika ortalama SKB ve DKB değerleri dikkate alındığında, 6. dakika DKB değeri hariç, üç grupta da fark anlamlı bulundu ($p<0001$). Üçüncü dakikada 1. dakikaya göre sistolik ve diastolik kan basıncı değişim yüzdesi istatististiksel olarak anlamlı bulunmadı (sırası ile p=0,454 ve p=0,196). Başlangıca göre 6. dakikadaki SKB artışının yüzdesinin ortalaması da farklı bulunmadı (p= 0,109).
Sonuç: Egzersiz sırasında obezite ile kan basıncı artış oranlarında farklılık görülmemesi, obezitenin egzersize fizyolojik cevabı bozmadığını düşündürmektedir.
Anahtar kelimeler: Vücut kitle indeksi (VKI), kan basıncı, egzersiz

Introduction

The effect of obesity to blood pressure increase was demonstrated in various studies before. The regular exercise is known to be able to decrease blood pressure. The increase in blood pressure with acute exercise is a physiological response. Obesity is known to be associated with cardiac structural change and volume overload in which insulin resistance is the cornerstone in cardiovascular alterations. Positive correlation between BMI and blood pressure levels was determined in the literature before [1,2].

We aimed to evaluate the effect of BMI in blood pressure response during exercise.

Methods

Between 2006 April and May, all patients who were referred for MPS to our center were searched from the records. 168 of them with normal myocardial perfusion scintigraphy were enrolled into the study. Blood pressure response of these patients during readmill cardiac drugs before exercise test [2] history and laboratory findings of heart disease. Baseline characteristics of patients were recorded from hospital database. Antropometric measurements of the subjects were taken. BMI is body weight in kilograms divided by the height in meters, squared, expressed as wt (in kg) /height (m2)[3]. They were divided into 3 groups according to BMI:18,5- 24,9 (normal-group 1), between 25-29.9 (over weight-preobese, group 2), between 30-39 (obese,group 3). At 1th, 3rd and 6th minutes of the treadmill tests according to Bruce protocol the values of systolic (SBP) and diastolic blood pressure (DBP) were determined from our database program. Exercise testing was performed according to ACC/AHA practice guidelines using a Bruce protocol modified by two warm-up stages [4,5].

Subjects were questioned for symptoms every 2 min and the heart rate, blood pressure, and a 12-lead electrocardiogram were recorded at baseline, at the end of each stage and at peak exercise.

Statistical analysis: Continuous data were reported as mean± SD or median (minimum-maximum) while categorical variables were reported as percentage (%). Chi- square was used in the comparison of the categorical variables. Comparisons between BP of groups were performed using the Kruskall-Wallis test. A p value <0.05 was considered significant. All statistical calculations were made with the SPSS 11.5 software package.

Results

There was no difference between the age, gender, presence of hypertension, diabetes mellitus of the groups (Table 1). The systolic blood pressures at 1st, 3rd minute of treadmill tests of the groups was statistically different (p< 0,001). Obese subjects had the highest values for diastolic and systolic blood pressure. There were also significant differences between the diastolic blood pressures at 1st and 3rd minute (p< 0,001). 40, patients from group I, 51 patients from group II, and 33 patients from group III could complete 6th minute. However while systolic blood pressures at 6th minute was different (p=0,002), there was no difference between diastolic blood pressures at that time (p=0,09) (Table 2). Whenever the alteration of systolic BP change with respect to time intervals was determined, no difference was observed between the groups (Table 3). The changes of diastolic BP between 1st and 3rd minute, 3rd and 6th minute, 1st and 6 th minute of three groups weren't different significantly (p values are 0.196, 0.109,0.241 respectively).

Table 1: Baseline characteristics of groups with different body mass index

	Group I (n=62)	Group II (n=88)	Group III (n=70)	p
Age (years)	52,45±11,84	52,48±11,31	51,34±9,68	0,777
Gender (Male)	34(54,8%)	48(54,5%)	31(44,3%)	0,357
Hypertension	15(24,2%)	30(34,1%)	28(40,0%)	0,153
Diabetes mellitus	4 (6,5%)	7(8,0%)	10(14,3%)	0,251

Table 2: Systolic and diastolic blood pressure levels of the groups with different body mass index

	Group I †	Group II †	Group III †	p
SBP (mmhg) 1st	130 (100-170)	130 (110-190)	140(100-210)	< 0,001
SBP (mmhg) 3rd	150(95-190)	150(120-230)	160(120-250)	< 0,001
SBP (mmhg) 6th	160(120-210)	160(130-220)	170(130-250)	0,002
DBP (mmhg) 1st	85(60-110)	90(70-120)	90(70-120)	< 0,001
DBP (mmhg) 3rd	90(70-110)	90(70-130)	100(80-140)	< 0,001
DBP (mmhg) 6th	100(70-110)	100(70-130)	100(70-120)	0,09

Values are given as median (minimum-maximum). Group I , II and III included 62, 88, 70 subjects at the beginning respectively.40, patients from group I, 51 patients from group II, and 33 patients from group III could complete 6th minute.

Table 3: The amount of the change of blood pressure between groups

	Group I*	Group II*	Group II*	p
Δ – SBD (1st-3rd minute)	15,38(-14,29-46,15)	12,54 (-5,88-41,67)	14,28(-11,76-70,00)	0,454
Δ – SBD (1st-6th minute)	20 (0-61,54)	20,00(5,88-63,64)	26,31(7,14-56,25)	0,055
Δ – SBD (3rh-6th minute)	6,66(-26,32-26,32)	6,66(-5,88-38,46)	6,66(-12,50-23,53)	0,601
Δ –DBP (1st-3rd minute)	11,11(-12,50-50,00)	11,11(-22,22-42,86)	10,00(-9,09-57,14)	0,196
Δ –DBP (1st-6th minute)	12,50(-12,50-66,67)	11,11(-22,22-42,86)	10,00(-12,50-33,33)	0,109
Δ –DBP (3rh-6th minute)	0(-12,50-22,22)	0(-15,38-33,33)	0(-12,50-22,22)	0,241

Values are given as median (minimum-maximum).
* Group I , II and III included 62, 88, 70 subjects at the beginning respectively.40, patients from group I, 51 patients from group II, and 33 patients from group III could complete 6th minute

Discussion:

The purpose of the treadmill test is to evaluate the response of cardiovasculer system to exercise. Treadmill exercise test is a frequently preferred dynamic exercise test. Dynamic exercise produce an increase in heart rate and blood pressure due to activated sympathetic tone. The balance between cardiac output and peripheral resistance modulated by changes in sympathetic nerve activity is needed in the blood pressure of healthy people[6]. In a mean follow up of 6.6 years with a study population of 6,145 patients, Gupta et al. found improved survival with the patients that had greater increase of systolic blood pressure at peak exercise [7].Obesity is a risk factor for cardiovascular complications. Elevated insulin levels with insulin resistance, activation of renal afferent nerves, plasma free fatty acids, angiotensin II, elevated leptin levels, potentiation of central chemoreceptor sensitivity, and impaired baroreflex sensitivity are the proposed mechanisms and mediators that have been postulated as causative agents of adrenergic overactivity in obesity [8]. In a study by Shibao et al. systolic blood pressure fell more in obese subjects because of a greater decrease in total peripheral resistance [9]. The relation between maladaptation of the cardiovascular system to exercise stress and pathogenesis of hypertension was suggested before. Manabe et al. examined the influence of baroreceptor reflex sensitivity (BRS) on response of BP to exercise [9]. In previous studies, it was reported that baroreflex had an important role in hemodynamic regulation during exercise; the shifting of the baroreflex operating point higher by central commands, ergoreflex or metaboreflex or both [11-15]. Manabe et al. showed the alteration of the arterial BP response to exercise by BRS and the affect of exercise intensity to this relationship. While in the initial phase of exercise the association of the baroreflex with the BP response was suppressive, it was accelerative at submaximal phase, especially in cases of preserved baroreflex function. The exercise induced BP elevation was related to the preservation of baroreflex function. The researchers thought in the submaximal phase the baroreflex system had an important role in the acceleration of sympathetic activity and in order to an adequate sympathetic support to adapt stress, preserved function of the baroreflex function was required [10]. Kumagai et al found that insulin resistance is independently associated with resting diastolic blood pressure and systolic blood pressure response to exercise [16]. Tsumura et al demonstrated that an exaggerated increase in blood pressure response to exercise is associated with an increased risk for hypertension [17]. Miyatake et al showed that alterations in body composition are related to the SBP response to an exercise [18]. In the Framingham Heart Study, exagerated DBP response to exercise was related to increased risk for hypertension in future [19]. Di Bello et al demonstrated that obesity leads to structural and functional change in heart due to insulin resistance and volume overload [20]. These changes may also have role in the different response of cardiovascular system to exercise in obese people.

In our study, we evaluated the effect of increased BMI on blood pressure response to acute exercise. With increasing BMI levels, DBP and SBP levels were also increased. As expected, obese subjects had the highest values of DBP and SBP levels similar to previous literature. There was no difference between the age, gender, presence of hypertension, diabetes mellitus of the groups. The positive effect of regular physical activity on lowering BP was shown in different age and study groups [21-23]. The development of adaptation of cardiovascular system to physical activity has an important role in this effect. In our study, the obese subjects showed the highest blood pressure levels and they also had highest BP with exercise. However the changes of BP were similar between different BMI groups. In various studies, it has been shown that the magnitude of change of the blood pressure response was tend to increase with obesity; the most prevalent reponse was seen with obese people. In this study, an important part of the patients couldn't finish the treadmill exercise test. This was especially prominent in obese patient group. The exercise capacities of the patients were seen to be restricted through increasing BMI values. The magnitude of change of blood pressure levels might be important significantly, if these patients were able to finish the test.

Conclusıon

Absence of this difference during exercise for obese people, implies that obesity didn't disturb the physiological response to the exercise.

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Coresponding author:
Guliz ERDEM YAZICI
Kırıkkale Yuksek Ihtisas Hospital
Phone: +90 3122139498
Fax:+903122230528
e-mail : gulizerdem76@yahoo.com