

Impact of Various Front-line Hypertensive Medication on Blood Pressure Control During Maximum Exercise Testing in Coronary Artery Disease Patients

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Abstract

It has long been known that blood pressure (BP) and cardiovascular morbidity are related. It is acknowledged that blood pressure during activity may serve as a more reliable indicator than resting blood pressure, which might not accurately reflect blood pressure at other times. Goals: 1) To assess how blood pressure behaves during physical activity in individuals with coronary artery disease (CAD) whose hypertension is managed with first-line antihypertensive medications. 2) To determine whether there were any variations in the front-line medication groups for the treatment of hypertension with respect to the ability of the medications to regulate blood pressure during physical exercise in patients with CAD. Methods: We retrospectively identified 49 CAD patients with hypertension (30 Males and 19 Females) from 68 stress tests. The patient was receiving pharmaceutical monotherapy, with an age of 52±10 years and a normal range rest arterial pressure (≤140/90 mmHg). 13 were on angiotensin converting enzyme inhibitors, 10 on diuretics, 12 on calcium antagonists, and 14 on beta blockers. Any of the following criteria, when present, led to the diagnosis of abnormal exercise behavior of blood pressure: peak systolic pressure exceeding 220 mmHg, systolic pressure rising by at least 10 mmHg/MET, or diastolic pressure increasing by at least 15 mmHg. Results: In 50% of CAD patients, beta blockers were the best treatment for physiologic response of arterial blood pressure (p<0.05), followed by calcium antagonists (36%), diuretics (31%), and angiotensin converting enzyme inhibitors (20%), which were the worst treatment for physiologic response (p<0.05). In conclusion, beta-blockers were the most effective medication in regulating blood pressure during exercise, whereas angiotensin converting enzyme inhibitors were the least effective. Calcium antagonists, diuretics, and beta-blockers were the least effective.

Keywords: Stress test, arterial hypertension, front-line antihypertensive drugs, CAD, blood pressure

INTRODUCTION

The current objective of blood pressure management is to minimize morbidity and mortality. This can be accomplished in a variety of methods, such as by exercise, cutting back on alcohol and sodium, losing weight, or in conjunction with pharmacological treatment [1–3].

Regularly engaging in moderate exercise, such as swimming, biking, and walking, has been demonstrated to be a valuable tool in helping hypertensive individuals with coronary artery disease lower their blood pressure [3].

In hypertensive patients, ambulatory blood pressure monitoring has demonstrated a higher percentage of measurements above normal values within a 24-hour period (pressure load). This can be

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attributed to various factors such as exercise, work, and waking up, which can cause greater damage to the target organ or increase the incidence of medical events linked to hypertension [4]. Antihypertensive medications should, therefore, be able to regulate blood pressure both at rest and during physical exercise.

The behavior of blood pressure during exercise gives essential information for the therapeutic evaluation of hypertensive persons since physical activity is a component of the treatment [5, 6]. Exercise testing is required for evaluation since it is more challenging to get accurate results using ambulatory blood pressure monitoring while the patient is engaged in activity [4, 7].

The aim of the research was to determine whether there were any variations in the capacity of individuals with cardiovascular disorders to control their blood pressure during physical activity between the different categories of frontline medications used to treat hypertension.

MATERIALS AND METHODS

68 patients with coronary artery diseases performed Treadmill Stress Test and were retrospectively evaluated at cardiac rehabilitation center while undergoing for cardiac rehabilitation program. Patients that met inclusion criteria were those who had primary hypertension, were receiving front-line anti-hypertensive medication on a regular basis, had a resting blood pressure measurement of 140/90 mmHg or less, and had no other significant medical conditions. The selection criteria were met by 49 patients (30 men and 19 females) with mean ages (\pm SD) of 52 ± 10 years.

29% of patients (n=14) were using antihypertension medication belonging to the beta-blockers group, 25% (n=12) used calcium antagonists, 20% (n=10) diuretics, and 27% of the patients (n=13) were using medicine that falls under the class of inhibitors of the angiotensin-converting enzyme (Table 1). All groups had comparable mean ages and resting systolic and diastolic blood pressure (Table 2). One of the following three conditions was met for blood pressure behavior under stress to be deemed abnormal [8]: systolic pressure on the stress peak exceeding 220 mmHg, variation in systolic pressure/MET (metabolic equivalent) exceeding or equal to 10 mmHg, or variation in diastolic pressure under stress exceeding 15 mmHg. Every test was symptom-limited, conducted on a treadmill, and followed either the original or modified Bruce protocols. Using a mercury-column device, blood pressure was taken noninvasively while the patient was in an orthostatic position on the treadmill. The blood pressure at rest was recorded on the left arm.

Table 1. Top medications used in each category.

Beta-blockers	Calcium Antagonists	ACEI	Diuretics
80% propranolol	62% phenylalkilamines	72% captopril	65% hctz
20% atenolol	38% dihydropyridines	28% others	35% clort

Table 2. Lists each drug group's age and blood pressure (BP). The group using beta-blockers had considerably lower systolic blood pressure during maximum stress (* $p < 0.05$) than the other three groups. Regarding the other factors, there were no notable variations between the groups.

Variables	Beta-blockers	Calcium Antagonists	ACEI	Diuretics
Age (years)	52 ± 11	51 ± 13	54 ± 14	54 ± 12
SBP rest (mmHg)	132 ± 09	124 ± 09	125 ± 10	131 ± 08
DBP rest (mmHg)	85 ± 07	83 ± 07	83 ± 10	81 ± 05
SBP stress (mmHg)	180 ± 02	203 ± 17	196 ± 22	201 ± 32
DBP stress (mmHg)	94 ± 17	84 ± 19	90 ± 15	86 ± 11

Statistical Analysis

The basis for the statistical analysis was ANOVA. Following the determination of significance, post hoc analysis was conducted using the student's t test with the Bonferroni correction for variables (age, systolic blood pressure) with a normal distribution. When comparing proportions (tensional response), the Mann-Whitney test was utilized, and when dealing with variables that lacked a normal distribution (diastolic blood pressure), the Chi-square test was applied. A p-value of less than 0.05 was deemed to be statistically significant.

Hctz: hydrochlorothiazide; clort: chlorthalidone; ACEI: angiotensin converting enzyme inhibitors.

The terms "systolic blood pressure", "diastolic blood pressure", "beta-blockers", "angiotensin-converting enzyme inhibitors", and "stress maximum under stress" refer to these physiological measures. The information is displayed as mean \pm standard deviation.

RESULTS

At rest, the groups' systolic and diastolic blood pressures were comparable in terms of age (Table 2). Patients taking beta-blockers had lower mean systolic pressure during maximal exercise compared to the other groups ($p < 0.05$). The values were as follows: 179 ± 02 mmHg for beta-blockers, 203 ± 17 mmHg for calcium antagonists, 198 ± 32 mmHg for diuretics, and 204 ± 22 mmHg for angiotensin converting enzyme inhibitors. Regarding the mean diastolic pressure readings during maximal exercise, there was no difference between the four groups ($p > 0.05$) (Table 2).

When it came to the blood pressure response to exercise, there was no discernible difference between the patient groups using calcium antagonists and diuretics. A physiological response in blood pressure was observed in 30% of patients using diuretics and 35% of patients taking calcium antagonists ($p = 0.40$). 49% of the patients on beta-blockers demonstrated a physiological blood pressure response to exercise; this difference from the other three groups was statistically significant ($p < 0.05$). Only 19% of the patients taking angiotensin-converting enzyme inhibitors demonstrated a physiological blood pressure response to exercise, which was much less than that of the other medication groups ($p < 0.05$) (Figure 1).

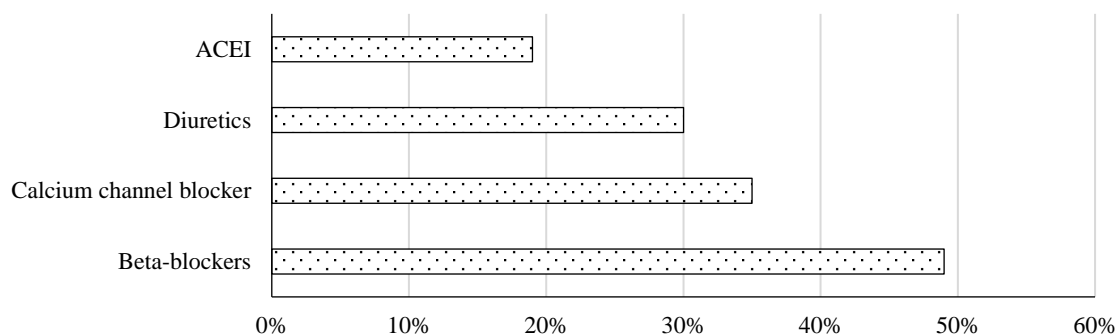


Figure 1. Physiological response of blood pressure to stress. Values of p are significant between groups, except for the calcium antagonists and diuretics groups.

DISCUSSION

According to certain studies, using captopril, an inhibitor of the angiotensin-converting enzyme, does not lower blood pressure when under extreme stress [9, 10]. The research by Manhem *et al.* on the effects of captopril on catecholamines, renin activity, angiotensin II, and aldosterone in plasma during physical exercise in hypertensive patients found that although the drug significantly reduced the formation of angiotensin II, it had no effect on the blood pressure's response to exercise [10]. The class of angiotensin-converting enzyme inhibitors proved to be the least successful in our study in regulating blood pressure during stressful situations. Since 72% of patients were taking captopril, we cannot rule out the possibility that other angiotensin-converting enzyme inhibitors could cause different kinds of

reactions. For example, alacepril was the subject of a study by Kinugawa *et al.* that showed a drop in blood pressure when under stress [11].

Kostis *et al.* evaluated the different effects of captopril and nadolol during exercise and showed that both drugs reduce the increase of diastolic blood pressure during exercise [9]. Nevertheless, despite the fact that using captopril reduced the systolic blood pressure at rest, nadolol reduced it more than captopril did. These results are consistent with our study, which found that individuals receiving beta-blockers had much lower systolic blood pressure during exercise and comparable diastolic blood pressure across all four groups. These varying reactions to exercise appear to be associated with the antihypertensive effect mechanism of each medication. While using beta-blockers lowers blood pressure by lowering cardiac output, using angiotensin-converting enzyme inhibitors lowers blood pressure by decreasing peripheral vascular resistance without interfering with cardiac output [9, 12].

In our investigation, there was no discernible difference in the blood pressure regulation between the diuretic and calcium antagonist groups during exercise. By directly acting as vasodilators on the smooth vascular muscles, calcium antagonists lower blood pressure and, as a result, peripheral vascular resistance [13, 14]. Dihydropyridines do not considerably change cardiac output, while phenylalkilamines negatively impact both chronotropism and inotropism, making them a heterogeneous class of medications [15]. Roberts *et al.* found no difference in blood pressure between captopril and nifedipine at rest or following exercise [16]. However, compared to the group on angiotensin-converting enzyme inhibitors, our results indicated that the group taking calcium antagonists had improved blood pressure control.

This could be a result of the fact that 62% of the patients in the calcium antagonist group were taking phenylalkilamines; hence, it is possible that a considerable proportion of patients experienced a drop in peripheral vascular resistance along with a decrease in cardiac output. During the first stages of treatment, thiazide diuretics lower blood pressure via decreasing volemia and ultimately cardiac output. But after 4 to 6 weeks, the principal way in which they work is by reducing peripheral vascular resistance [17]. Since the timing of the medication was not specified in our study, differences in the diuretics' mode of action may arise.

Since all of the patients in this study had controlled blood pressure at rest, even if the amount of time between taking the medicine and performing the exercise test was not well monitored, we can presume that anti-hypertensive medication was used appropriately. Because of the noise from the treadmill and the movement of the muscles, exercise tests can make it difficult to measure blood pressure, especially diastolic pressure. However, Pickering *et al.* discovered a strong association between the systolic and diastolic blood pressure readings for a certain heart rate acquired during exercise testing and those obtained by ambulatory blood pressure monitoring [17, 18]. It is noteworthy that some writers have used indirect measurements in a variety of clinical and therapeutic contexts to evaluate the systolic and diastolic pressures during exercise. Without a doubt, this has advanced our knowledge of the mechanisms guiding blood pressure behavior during exercise [9–12, 14, 15, 19].

CONCLUSION

Given that the goal of treatment is appropriate blood pressure regulation throughout rest, daily activities, and exercise, the assessment of hypertension patients' hemodynamic reactions during a stress test can yield valuable information for the therapeutic decision among patients with coronary artery diseases. Our findings imply that beta-blockers may be more beneficial than angiotensin-converting enzyme inhibitors in the management of blood pressure in hypertensive patients whose blood pressure responds excessively to exercise.

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