

Effects of Isometric Handgrip Exercise on Blood Pressure and its role in Identifying Hypertensive Risk Individuals

Kanmani Karthikkeyan¹, K. Latha², V Gokulnathan³

ABSTRACT

Introduction: Hypertension is a long term medical condition in which blood pressure in the arteries is persistently elevated and it is a major health care burden. Long standing hypertension leads to cardiovascular complications and cerebrovascular accidents. It also causes neuronal disturbances affecting the autonomic nervous system. Isometric handgrip exercise test is a non-invasive physiological test which is done using a handgrip dynamometer. It can be used to detect the impairment in the autonomic activity which is seen in individuals who are prone to develop hypertension in the future. Thus, the aim of the present study was to assess the efficacy of isometric hand exercise on blood pressure in identification of hypertensive risk individuals and also to determine the role of handgrip Dynamometer in identifying hypertensive risk individuals.

Material and methods: The present study was a cross-sectional study done among 100 healthy normotensive individuals was taken in the study. All participants were apparently healthy at the time of isometric handgrip test. Cardiovascular parameters like systolic blood pressure, diastolic blood pressure and heart rate were measured before the exercise after following all standard precautions. The subjects were asked to perform the isometric handgrip exercise using the handgrip dynamometer. Blood pressure was recorded at three occasions– before the test, during the test and 5 minutes after the test.

Results: In the present study, out of 100 individuals, the mean age was found to be 55 years among the hypertensive individuals. The mean weight was found to be around 78.4± 15.0. The mean value of height was found to be 1.42± 0.06. The mean value of increase in SBP and the DBP during isometric handgrip exercise was significantly higher than the baseline values. The mean difference for SBP was 9.85 with p value 0.0003 which was observed to be highly significant.

Conclusion: Isometric handgrip exercise test was found to be useful as a screening test in identification of individuals at risk of developing hypertension.

Keywords: Isometric Hand Grip Exercise, Blood Pressure, Hypertension, Cardiovascular Disease

INTRODUCTION

Hypertension is a long term medical condition in which the blood pressure in the arteries is persistently elevated and it is a major health care burden worldwide. Hypertension is common in developing countries, particularly in urban areas where the rate of awareness is low. About 90-95% of cases are primary, defined as high blood pressure due to non-specific lifestyle and genetic factors. Risk factors which increase the prevalence of hypertension include population growth, unhealthy diet, and tobacco use, consumption of alcohol, excess weight, persistent stress, high cholesterol, diabetes

mellitus and lack of physical activity. The remaining 5-10% of cases is secondary to an identifiable cause such as chronic kidney disease, endocrine disorder, pregnancy.^{1,2}

Isometric Handgrip Exercise is a Physiological test which is done using a Handgrip Dynamometer. In Isometric Exercise, contraction principally causes a change in the tension of the muscle with little change in the length e.g. lifting or pushing heavy weights and contracting muscles against fixed objects. The blood pressure is regulated by autonomic nervous system. An increased sympathetic tone and a decreased parasympathetic tone have been demonstrated in normotensive individuals who are at risk of developing hypertension in future. This impairment of autonomic activity can be detected by application of a physical stress test (isometric handgrip exercise test).^{3,4}

An early diagnosis of underlying hypertension is necessary to prevent cardiovascular complications and cerebrovascular accidents. Isometric Handgrip Exercise test can be a simple and effective screening test to identify individuals who are at risk of developing hypertension.⁵

Hypertension (HTN) is one of the most prevalent and powerful risk factors for cardiovascular disease. It is estimated to affect nearly one quarter of the adult population, and resulted in 7.1 million deaths annually. Further discouraging is the prospect that the prevalence of HTN is projected to increase 60% by 2025. Recent research from the works of Framingham Heart Study has found that in healthy middle-aged and elderly individuals, the residual lifetime risk for developing HTN is 90%.^{6,7}

There is great concern regarding the global efforts towards the primary, secondary, and tertiary prevention of HTN. It is undeniable that the treatment of HTN reduces the risk of cardiovascular disease, cerebrovascular disease, and mortality. The first-line therapy for HTN must be of lifestyle modifications (i.e. exercise, diet, smoking cessation, etc.) aimed at reducing HTN risk factors.⁸

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However, the current mainstream therapy for HTN is the prescription of anti-hypertensive medications. Poor effectiveness and adherence to these prescriptions has resulted in low rates of blood pressure control. Moreover, research has demonstrated that ~50% of HTN patients may still maintain elevated resting arterial blood pressure (ABP). Thus, the ineffectiveness of HTN therapies has necessitated the need to investigate novel therapeutic alternatives. Isometric or static contractions differ from dynamic movements as they contain an application of force but no change in muscle length.^{9,10}

Early studies involving isometric exercise training, examined whole-body isometric exercise and the effects of training on resting ABP. In a study done by Kiveloff and colleagues observed that in un-medicated hypertensives, following 5 to 8 weeks of isometric training, 3 times per week, decreases in SBP of 4 - 28 mm Hg and DBP of 2 - 14 mmHg. Later studies investigated the benefits of a simpler isometric training protocol: isometric handgrip (IHG) exercise. For example, 8-weeks of IHG training in normotensive individuals resulted in reductions in resting SBP of 12 mmHg and DBP of 14 mmHg. This protocol involved 4 isometric contractions of the dominant arm for 2 minutes, separated by 3 minutes of rest, at 30% maximum voluntary contraction (MVC), and performed 3 times per week.¹¹

Early research in the area of isometric exercise focused on the differences between isometric and dynamic exercise. The blood pressure and heart rate responses to isometric exercise are influenced by the force of the contraction, the size of the contracting muscle and the length of time contracted. Similar to strength exercise, the cardiovascular response is characterized by an increase in cardiac output and ABP, resulting in a pressure load on the heart with little change in total peripheral resistance.¹² Thus, the aim of the present study was to assess the efficacy of isometric hand exercise on blood pressure in identification of hypertensive risk individuals.

MATERIAL AND METHODS

The present study was a cross-sectional study in which data collection was done after obtaining permission from Institutional Ethical Committee. The purpose of the study was explained to the subjects and a written informed consent was obtained. Total 100 healthy normotensive individuals were chosen as subjects and their baseline blood pressure was recorded. The subjects are asked to perform the isometric handgrip exercise at 30% of T-max for two minutes. During the exercise, the blood pressure was recorded from the non-exercising arm. The blood pressure was recorded again 5 minutes after the exercise.

All participants were apparently healthy at the time of isometric handgrip test. Cardiovascular parameters like systolic blood pressure, diastolic blood pressure and heart rate were measured before the exercise after following all standard precautions. Isometric handgrip test was performed by dominant hand for 1 minute at 30% of maximum voluntary contraction. SBP, DBP and HR were recorded immediately

after the exercise and recovery HR, SBP and DBP were recorded at 1st, 2nd and 3rd minutes of exercise.

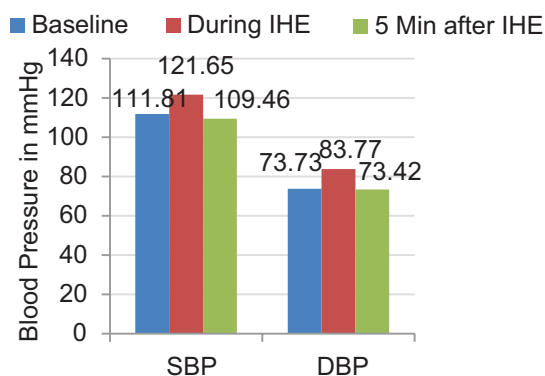
Changes in cardiovascular parameters before the exercise and after the exercise were recorded. Adult individuals of age group of 18-35 years were taken in this study. Normotensive individuals with (BP \leq 120/80 mm of Hg) along with individuals of either sex were included in the present study. Patients with hypertension with (BP $>$ 120/80mm Hg) and family history of hypertension or are currently taking medications for hypertension, obesity and diabetes were excluded from this study. Patients who have participated in any isometric training within one month of the onset of study were also not included in the study.

STATISTICAL ANALYSIS

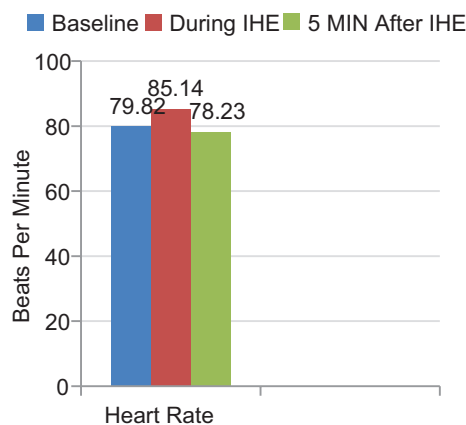
The data was entered into the Microsoft excel sheet and was analyzed with the help of SPSS software (Statistical Package of Social Sciences). Continuous variables were summarized as mean, standard deviations or 95% confidence interval, whereas categorical variables were summarized as relative frequencies in the form of tables and graphs.

RESULTS

In the present study, out of 100 individuals, the mean age was found to be 55 years among the hypertensive individuals. The mean weight was found to be around 78.4 \pm 15.0. The mean value of height was found to be 1.42 \pm 0.06. The mean value



Graph-1: Shows the distribution of data based on systolic, diastolic blood pressure and heart rate among the study subjects



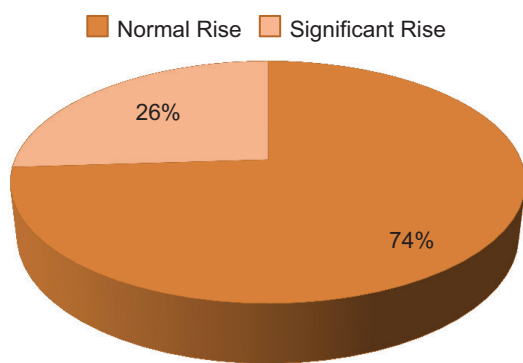
Graph-2: Shows the distribution of data based on systolic, diastolic blood pressure and heart rate before, during and after 5 minutes after the isometric handgrip exercise among the study subjects

Parameters	Baseline N=100 (Mean±SD)	During IHE N=100 (Mean±SD)	t value	p value
SBP(mm/Hg)	111.81±14.05	121.65±15.17	4.23	0.0003
DBP(mm/Hg)	73.73±9.70	83.77±9.55	4.88	0.0001
HR(beats/min)	79.82±4.79	85.14±5.02	9.51	0.0001

Table-1: Shows the distribution of data based on systolic, diastolic blood pressure and heart rate among the study subjects

Parameters	Baseline N=100 (Mean±SD)	5 Min after IHE N=100 (Mean±SD)	t value	p value
SBP(mm/Hg)	111.81±14.05	109.46±13.34	1.19	0.244
DBP(mm/Hg)	73.73±9.70	73.42±8.22	0.19	0.84
HR(beats/min)	79.82±4.79	78.23±3.84	2.74	0.003

Table-2: Shows the distribution of data based on systolic, diastolic blood pressure and heart rate before, during and after 5 minutes after the isometric handgrip exercise among the study subjects



Rise in BP during IHE

Graph-3: Shows the distribution of data based on rise in BP during isometric handgrip exercise among the study subjects

of increase in SBP and the DBP during isometric handgrip exercise was significantly higher than the baseline values. The mean difference for SBP was 9.85 with p value 0.0003 which was observed to be highly significant. The mean difference for DBP was 10.04 with p value 0.0001 which was found to be very highly significant (Table and Graph 1). The mean value of difference in SBP and the DBP after 5 minutes of exercise was not significant from the baseline values. The mean difference for SBP was a fall of 2.35 mmHg with p value 0.2444 which was not found to be statistically significant. The mean difference for DBP was a fall of 0.31 mmHg with p value 0.8483 which was not statistically significant (Table and Graph 2). Out of the 100 healthy individuals, rise in both SBP (of 20mmHg) and DBP (of 10mmHg) during the isometric handgrip exercise was seen among 26 individuals (Graph-3).

DISCUSSION

From the results of the study, it is clearly revealed that there was a significant rise in systolic blood pressure and diastolic blood pressure during the isometric handgrip exercise. This response is mediated by combined central and peripheral afferent input to medullary cardiovascular centers. In normal individuals increase in BP is mediated by rise in cardiac output.¹³ Furthermore, it was noted in the literature that there is

increase in concentration of metabolites like lactic acid and adenosine within skeletal muscle interstitium. These substances increase the discharge of afferent fibers causing a potent reflex increasing the sympathetic nerve activity. In healthy individuals, the SBP and DBP return to normal in 5 minutes of stoppage of the exercise due to a reflex response resulting in decreased sympathetic activity and increased parasympathetic activity.¹⁴

The quicker return of BP to its resting level indicates the healthy state of the individuals. The individuals who have a significant rise in both systolic BP(>20 mm Hg) and diastolic BP (>10 mm Hg) during IHE took more time to return to their baseline BP. Out of the 100 healthy individuals 26 belonged to this category. These 26 individuals may have the tendency for developing Hypertension in future. A reduced reflex sympatho-inhibition could lead to development of hypertension due to an increase in the sympathetic vasomotor tone.¹⁵

In a study done by Sandhu JS et al, the effects of Isometric handgrip training on heart rate and arterial pressure in normotensive individuals have been studied. About 50 healthy, normotensive, untrained subjects (25 males, 25 females) with ages varying from 19-35 years were recruited. The results of the study showed that isometric handgrip training decreased resting heart rate and arterial pressure in normotensive individuals. Therefore, this form of exercise training can be used as a non-pharmacological intervention in lowering arterial pressure and heart rate and these findings are in consistent with the results of the present study.¹⁶

A study done by Stone MH et al, observed reduction in SBP and DBP of 9.5 and 9 mmHg respectively and SBP remained significantly decreased for upto 14 days after completion of isometric training whereas, other studies have reported a significant decrease in SBP and heart rate after training without any changes in DBP. There was no statistically significant change in the mean SBP, DBP and HR in controls from the start of the study (0 weeks) till its completion (8 weeks).¹⁷

It was found from the previous research that after 8 weeks, there was a significant decrease in mean SBP, DBP and heart

rate in study group of isometric training, in comparison with 0 weeks. This fall in SBP may be due to significant drop in the heart rate which may be due to less sympathetic nerve activity. The decrease in DBP may be due to adaptations in the vascular system that leads to reduction in resistance of vascular systemic system. Another reason are reduction in plasma norepinephrine levels or decrease in vascular sensitivity to norepinephrine, alterations in oxidative stress, improved endothelium dependent vasodilation and the modulation of autonomic nervous system in the form of reduction in basal sympathetic nerve activity.^{17,18}

It was revealed from the work of the previous research that in young normotensive off springs of hypertensive parents there was an increased sympathetic tone and a decreased parasympathetic tone. Autonomic nervous system regulates the blood pressure. With the application of various physical stress tests of hypertensive parents, this impairment of the autonomic activity can be found in the young off springs.¹⁹

The static contraction of even a small mass of muscle causes a steady increase in the arterial pressure, with a rise in the heart rate and the cardiac output, thus primarily producing a pressure load on the heart. Exercise can lead to a change in the tension of the muscle with little change in the length, is termed as isometric or static such as lifting or pushing heavy weights and contracting muscles against fixed objects, in contrast to isotonic or dynamic exercises in which contraction of the skeletal muscle which leads to a change in the length of muscle, like running, swimming, etc.²⁰

CONCLUSION

An early diagnosis of underlying hypertension is necessary to prevent cardiovascular complications and cerebrovascular accidents. Isometric Handgrip Exercise Test can be used as a simple effective screening test to identify individuals who are at risk of developing hypertension.

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