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Original Research Article

Comparative Study of Cardiovascular Response to Sustained Handgrip Exercise Test in Stage1 Essential Hypertensive and Normotensive Subjects

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Abstract: Hypertension is most prevalent disorder worldwide and it is major risk factor for cardiovascular complications. Our knowledge is still limited about the cause of increased cardiovascular risk in essential hypertension. Autonomic nerves supplying the heart may also be involved in hypertension causing cardiac autonomic neuropathy (CAN). Evaluation of circulatory responses during sympathoexcitatory stress like isometric muscle contraction i.e. sustained hand grip (SHG) is a useful method to assess cardiac function. Therefore the present study was aimed to assess hemodynamic response (blood pressure and heart rate response) during sustained hand grip test in newly diagnosed stage 1 essential hypertensive subjects and compare the same with age, BMI and gender matched normotensive controls. This study was carried out at Department of Physiology, B. J. Medical College, Pune. Fifty newly diagnosed stage 1 essential hypertensive subjects were included in study group and fifty age and gender matched healthy normotensive subjects were included in control group. The difference between the systolic, diastolic blood pressure records (DBP) and heart rate just before the release of contraction at 30% of MVC and just before starting handgrip maneuver, was taken as a measure of sympathetic autonomic cardiac functions. In the present study the blood pressure response (ΔSBP, ΔDBP) and heart rate response (ΔHR) were statistically significantly increased ($p<0.05$) in newly diagnosed stage 1essential hypertensive subjects as compared to normotensive subjects during sustained isometric hand grip test. As there is increased blood pressure and heart rate response during sympathetic stress like sustained handgrip test we concluded that there is increased sympathetic activity in stage 1essential hypertension.
Keywords: Hypertension, sustained hand grip test (SHG), cardiac function, sympathetic stress

INTRODUCTION

Hypertension prevalence is approximately 26% worldwide [1]. In India it is predicted that hypertensive individuals will double from 118 million in 2000 to 213 million by 2025 [2]. Worldwide 80 to 95% of hypertensive subjects have essential hypertension. Worldwide essential hypertension has been responsible for 9.4 million deaths and 7% of disability adjusted life years [3]. Hypertension is major risk factor for cardiovascular complications like myocardial infarction, retinopathy, arrhythmias and sudden death [4]. Hypertension may be associated with peripheral neuropathy, sensory neuropathy [5] ischemic optic neuropathy. [6] Autonomic nerves supplying the heart may also be involved in hypertension causing cardiac autonomic neuropathy (CAN) [5,7]. Our knowledge is still limited about the cause of increased cardiovascular risk in essential hypertension.

Evaluation of circulatory responses during sympathoexcitatory stress like isometric muscle contraction i.e. sustained hand grip (SHG) is a useful method to assess cardiac function [8]. Relatively little is known about the hemodynamic responses to sustained handgrip in stage 1 essential hypertension. This information is very important because activities

involving isometric exercises i.e. weight lifting are performed daily by many people without exact knowledge of hemodynamic consequences. If any abnormality detected in early stage of hypertension, further complication can be prevented.

Therefore the present study was done to understand hemodynamic responses to sympathetic stress like sustained handgrip in stage 1 essential hypertensive subjects according to JNC 7 and normotensive subjects. It is also helpful clinically treating the hypertensive patients and preventing the complications in high risk hypertensive patients.

Aim and Objectives

To measure blood pressure and heart rate response during sustained hand grip test in newly diagnosed stage 1 essential hypertensive subjects and compare the same with age and gender matched normotensive control.

MATERIAL AND METHODS

The study was designed as analytical, cross-sectional, comparative study in the Department of Physiology of BJGMC medical college, Pune. The synopsis of study protocol was submitted to the institutional ethics committee and approval was obtained. Study was conducted from December 2013 to September 2015. First screening was done according to inclusion-exclusion criteria.

Sample Size

By simple random sampling 100 subjects were selected and grouped as following:

Group	Selected subjects
Control Group (Normotensive)	Normal healthy males : 50
Study Group (Hypertensive)	Newly diagnosed stage 1, essential hypertensive males: 50

Inclusion criteria

For study group newly diagnosed essential hypertensive males in the age group between 35 - 50 years having stage 1hypertension as per JNC 7 criteria with systolic blood pressure upto159 mm of Hg, diastolic blood pressure up to 99 mm of Hg were included in the study. For control group healthy normotensive age, body mass index (BMI) and gender matched 50 subjects with sinus rhythm on ECG were selected.

Exclusion criteria

For both study group and control group obese person having BMI ≥ 30 were excluded. Subjects having history of cardiac diseases, renal or endocrinal diseases, peripheral nervous system diseases, peripheral vascular disorder like Reynaud's disease, diabetes mellitus, bronchial asthma, alcohol abuse and tobacco chewing or smoking, those who regularly practice yoga or exercise training, secondary hypertension, Subjects on drugs like β2 agonist, antagonist were excluded.After explaining study and taking written informed consent blood pressure and heart rate response was measured and compared in two groups during Sustained Hand Grip (SHG) test. All the subjects were called in the morning hours between 10 am to 12 noon to avoid diurnal variations in autonomic functions. The subjects were instructed to avoid drinking tea and caffeine containing beverages for minimum 8 hours prior to testing. Subjects were examined in quiet room at room temperature. Heart rate response and blood pressure response were measured after a mandatory 30 minutes rest period.

Sustained hand grip test (SHG) [9]

Maximum voluntary contraction (MVC) was recorded by asking the subjects to squeeze the bars of hand grip dynamometer by dominant hand to produce a maximum effort as much as possible and maintaining the maximal effort for 2-3 sec. Three trials were given with interval of 10 sec between each trial to avoid fatigue.

Recording of BP at 30% of MVC

The subject was asked to apply pressure on a handgrip dynamometer for 1 minute at 30% of maximal voluntary contraction and simultaneously the blood pressure changes were observed by using automatic digital machine. The difference between the systolic, diastolic blood pressure records (DBP) and heart rate just before the release of contraction and just before starting handgrip maneuver, was taken as a measure of the response.

Interpretation [10]

- Normal: ≥16 mmHg rise in DBP,
- Borderline: 11-15 mmHg rise in DBP,
- Abnormal: ≤10 mmHg rise in DBP

Statistical Analysis:

The results were given as Mean ± Standard Deviation. Comparisons were performed using z -test for two groups. A p-value of less than 0.05 was considered as statistically significant. p-value <0.001 was considered statistically highly significant. Statistical software namely SPSS (Statistical Package for the Social Science) version 20 was used for the analysis of data. Microsoft word and Microsoft excel have been used to create text documents, graphs and tables etc.

RESULTS

Table−1: Demographic profile among hypertensive and normotensive groups.

Parameters	**Hypertensive n=50**	**Normotensive n=50**	**z-value**	**p-value**
	Mean ± SD	Mean ± SD		
Age (Years)	44.06 ± 3.157	44.70 ± 3.413	0.97	>0.05
BMI (kg/m2)	24.93 ±1.760	24.87 ± 2.280	0.14	>0.05
p values <0.05 : statistically significant*, p values <0.0001: statistically highly significant**, p values >0.05 : not significant				

Table−2: Blood pressure response to sustained hand grip (SHG).

Parameters	Hypertensive n=50	Normotensive n=50	z-value	p-value
	Mean ± SD	Mean ± SD		
ΔSBP (mm Hg)	20.58±3.37	18.20 ±2.22	4.17	p<0.0*
ΔDBP (mm Hg)	18.78 ±2.64	17.74 ±2.23	2.13	p<0.0*
p values <0.05 : statistically significant*, p values <0.0001: statistically highly significant**, p values > 0.05 : not significant.				

Table−3: Heart rate response to sustained hand grip (SHG).

Parameters	Hypertensive n=50	Normotensive n=50	z –value	p-value
	Mean ± SD	Mean ± SD		
ΔHR (beats/min)	13.52 ± 2.71	12.30 ± 2.60	2.25	p<0.05*
p values <0.05 : statistically significant*, p values <0.0001: statistically highly significant**, p values >0.05 : not significant				

DISCUSSION

Hypertension is the world's most prevalent cardiovascular disorder affecting approximately 26% worldwide population.[2] Hypertension leads to tachycardia, arrhythmias and sudden death. Hypertension may be associated with peripheral neuropathy, sensory neuropathy[5] ischemic optic neuropathy [6]. Autonomic nerves supplying the heart may also be involved in hypertension causing cardiac autonomic neuropathy (CAN) [13,15]. Our knowledge is still limited about the cause of increased cardiovascular risk in essential hypertension. Evaluation of circulatory responses during sympathoexcitatory stress like sustained hand grip (SHG) is a useful method to assess cardiac function. Therefore in the present study cardiac functions were studied in early stage of essential hypertension. Blood pressure and heart rate responses were measured during sustained hand grip test in newly diagnosed stage 1 (according to JNC7) essential hypertensive subjects and the same were compared with age and gender matched normotensive control.

It was observed that the mean value of rise in blood pressure response (Δ DBP, Δ SBP) and heart rate response (ΔHR) in hand grip test were statistically

significantly higher in stage 1essential hypertensive group as compared to normotensive group.

Our results were also in accordance with Hoel BL [11] who studied the hemodynamic responses to sustained handgrip in hypertensive patients and found increase in systolic and diastolic blood pressure and heart rate in all hypertensive patients in sustained hand-grip of 30% maximum voluntary contraction (MVC).

In sustained hand grip test, increase in blood pressure may be due to increase in the concentration of metabolic waste substances like lactic acid and adenosine within the skeletal muscle interstitium. These substances increase the discharge of group IV (metaboreceptors) afferent fibers and initiate a potent reflex increasing sympathetic nerve activity. This leads to vasoconstriction which increases blood pressure [12]. In sustained hand grip test, increase in diastolic blood pressure is due to exercise induced increase in sympathetic activity mediated by the alpha adrenergic receptors of the autonomic nervous system [13].

Recruitment of new motor units to maintain muscle tension expands the excitation of the central nervous system. The voluntary activity increases the excitatory state of the central nervous system and results in a possible increase in sympathetic and a possible decrease in parasympathetic outflow, which explains increased blood pressure and heart rate response [14]. Due to muscle fatigue there is increased voluntary effort to produce a certain force. This increased effort stimulates central nervous system, as a result sympathetic stimulation increases leading to an increased heart rate and blood pressure [14].

Heart rate (HR) increases first as a result of vagal withdrawal and afterwards because of both vagal withdrawal and sympathetic stimulation during hand grip test [15].

Increased cardiovascular response (Δ DBP, Δ SBP and Δ HR) in stage 1 essential hypertension group suggested that there may be increased sympathetic activity in hypertensive group than normotensive group. This type of autonomic dysfunction in stage 1 essential hypertension may be due to some abnormalities like - cardiac autonomic neuropathy in hypertensive subjects leading to myelin degeneration and axonal degeneration due to hypoxia, oxidative stress, chronic inflammation, free radical damage to autonomic nerves [5] or it can be caused by strong stimulation of the sympathetic nervous system during states of anxiety and stress. There is excitation of the hypothalamus by different types of stress [16].

There is increased blood pressure and heart rate response during sympathetic stress like sustained handgrip test in stage 1essential hypertensive subjects as compared to normotensive subjects. In the present study as there are altered sympathetic cardiac autonomic functions it can be concluded that there is increased sympathetic activity in stage 1essential hypertension.

Application of this study

- Cardiac autonomic functions are altered in early stages of essential hypertension. Autonomic nervous system dysregulation like increased sympathetic nervous system activity is present in stage 1 essential hypertension.
- If this autonomic dysregulation is diagnosed early by doing simple hand grip tests, it will be of great help in identification of high risk subjects having increased sympathetic activity that are prone to various complications like arrhythmias and sudden death.
- While treating essential hypertension along with antihypertensive medications, life style modifications like pranayama and meditation may be advised to balance the increased sympathetic activity in early essential hypertension.

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