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Physiology

ASSESSMENT OF PARASYMPATHETIC AUTONOMIC FUNCTIONS IN STAGE 1 ESSENTIAL HYPERTENSION BY DEEP BREATHING TEST

Talele Pallavi Tutor, Dept of Physiology, B. J. Government medical college, Pune.

Badhe Yuvaraj* Senior Resident, Dept of Medicine, MIMER medical college,Talegaon, Pune. *Corresponding Author

ABSTRACT Essential hypertension is having more incidence of resting tachycardia and arrhythmias. Resting heart rate is the index of vagal tone. Autonomic nerves supplying the heart may also be affected in essential hypertension causing cardiac autonomic neuropathy. When the parasympathetic system is abnormal, deep breathing induced changes in heart rate decrease i.e. heart rate variability (HRV) decreases. Parasympathetic autonomic functions are less studied in stage 1 essential hypertension. So the present study was aimed to measure E:I ratio during deep breathing in stage 1 essential hypertensive subjects. Study designed as analytical, cross-sectional, comparative study in the Department of Physiology B J medical college and hospital, Pune. 50 newly diagnosed essential hypertensive male subjects in the age group of 35 -50 years having stage 1 hypertension according to JNC 7 criteria were selected in study group. Healthy age and gender matched, 50 normotensive subjects were included in control group. After informed consent, E:I ratio was measured during deep breathing in the study and control group. Comparisons were performed using 'z-test' in the two groups. During deep breathing test E:I ratio was significantly decreased in stage 1 essential hypertensive subjects as compared to normotensive subjects. ($p<0.05$) Conclusion: The parasympathetic autonomic activity is decreased in stage 1essential hypertensive subjects as compared to normotensive subjects.

KEYWORDS : Hypertension, parasympathetic autonomic functions, E:I ratio, deep breathing test,etc.

Introdction:
Hypertension prevalence is approximately 26% worldwide. About 80-90 % hypertensive subjects have essential hypertension.[1] Essential hypertension is having more incidence of resting tachycardia and arrhythmias. This suggests either abnormal increase in sympathetic tone or abnormal decrease in parasympathetic tone. [2] Vagal tone in human beings brings firing rate of SA node from its intrinsic rate of 90 - 120 beats/min to the actual heart rate of about 72 beats/min. [3] At rest the vagal i.e. parasympathetic influence on SA node predominates over sympathetic influence. Therefore, resting heart rate is the index of vagal tone.[4]

Essential hypertension may be associated with peripheral neuropathy, sensory neuropathy,[5] ischemic optic neuropathy[6]Autonomic nerves supplying the heart may also be affected in hypertension causing cardiac autonomic neuropathy (CAN).[5,7] Cardiovascular autonomic neuropathy (CAN) causes abnormalities of heart rate and defective peripheral vascular dynamics.

The heart rate varies with the phases of respiration. It accelerates during inspiration and decelerates during expiration. This is known as sinus arrhythmia. [8] Deep breathing induced changes in heart rate occur because of alterations in cardiac parasympathetic activity. When the parasympathetic system is abnormal, deep breathing induced changes in heart rate decrease i.e. heart rate variability (HRV) decreases.[9]

In most autonomic disorders, parasympathetic function is affected before sympathetic function, so heart rate variability on deep breathing provides a sensitive screening measure for parasympathetic dysfunction in many autonomic disorders.[10] Parasympathetic autono mic functions are less studied in stage 1 essential hypertension. With this background present study was aimed to assess parasympathetic autonomic functions in stage 1 essential hypertension.

Aim and Objectives:
To measure parasympathetic autonomic functions in newly diagnosed stage 1 essential hypertensive subjects using E:I ratio and compare the same in age and gender matched normotensive controls.

Materials and Method:
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.

Inclusion criteria:
For study group newly diagnosed essential hypertensive male subjects 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. For control group healthy normotensive age, gender and body mass index (BMI) 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, E:I ratio was measured and compared in both the groups during deep breathing 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. E:I ratio was measured after a mandatory 30 minutes rest period.

Sample size:
In the present study after screening according to inclusion and exclusion criteria, 50 newly diagnosed essential hypertensive male subjects in the age group of 35 -50 years having stage 1 hypertension according to JNC 7 criteria were selected in study group. Healthy age and gender matched, 50 normotensive subjects were included in control group.

E: I ratio: [11]
The subject was in supine position with all ECG leads attached. A baseline recording of ECG was done for 30 sec. The patient was visually guided to breathe slowly and deeply at 6 cycles per minute. The E:I ratio was calculated from largest RR interval during expiration and smallest RR interval during inspiration. Continuous ECG record was obtained. The average value of 3 cycles was computed for each subject.

Calculation:[12]
E: I ratio:
(Longest RR interval during deep expiration/Shortest RR interval during deep inspiration)

Interpretation of E:I ratio :[1399]

(Normal = > 1.21, Borderline= 1.11-1.20, Abnormal = <1.10)

Statistical Analysis:

The results were given as Mean ± Standard Deviation. Comparisons were performed using z-test in the two groups. A p-value of less than 0.05 was considered as statistically significant. Statistical software 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

Table no. 5: Comparison of E: I ratio between hypertensive and normotensive groups.

Parameters	Hypertensive N=50		Normotensive N=50		z-value	p-value
	Mean	SD	Mean	SD		
E:I ratio	1.06	0.085	1.23	0.052	12.34	<0.0001**
p -value < 0.05 : statistically significant*, p value <0.0001: statistically highly significant**, p values > 0.05 : not significant.						

Discussion:

In the present study we got statistically significant lower mean value of E: I ratio in stage 1 essential hypertensive group as compared to normotensive group (p < 0.0001**). In hypertensive individuals, there is no increase in heart rate during inspiration because of loss of beat to beat variation. So ECG finding was longer R-R interval as compared to healthy individuals during phase of inspiration. So E:I ratio was reduced in hypertensive individuals may be due to baroreceptor desensitization.

Endukuru C et al (2014) also showed significant decrease in heart rate response to deep breathing test in hypertensives as compared to normotensives and concluded decreased parasympathetic activity leads to decreased heart rate variability with respiration.[14] Decreased parasympathetic activity in hypertension might be due to decreased baroreflex sensitivity.12 Causes for decreased baroreflex sensitivity may be –[15]

1. Decreased vascular elasticity and endothelial damage because of atherosclerosis and aging.
2. Alterations in the release of various factors from endothelium.
3. Enhanced circulating renin, angiotensin II and action of circulating angiotensin II on brain (area postrema and nucleus tractus solitarius).

Decreased E:I ratio in stage 1 essential hypertension suggests cardiac autonomic neuropathy. Hypertension may be a risk factor for peripheral neuropathy, even in the absence of diabetes. Impaired vascular supply to peripheral nerves leads to morphological changes and decreased nerve function which improves with antihypertensive medication.[7, 16] The exact mechanism responsible for hypertension related axonal or demyelinating neuropathy is not known. Metabolic and vascular disturbances lead to structural and functional changes in blood vessels supplying peripheral nerves, resulting in ischemia. This induces oxidative stress and injury to peripheral nerves because of reactive oxygen species (ROS). [1617,18]

As there is statistically significant decreased E:I ratio in stage 1 essential hypertensive subjects, we conclude that there is decreased parasympathetic activity in stage 1 essential hypertensive subjects.

Application of the study:

1. It will also help clinically treating the hypertensive patients.
2. If any abnormality is detected in parasympathetic autonomic functions in early stage of hypertension, future complications can be prevented.
3. People with cardiac autonomic neuropathy can undergo yoga and lifestyle modification to prevent further damage and complic ations.

There was no any conflict of interest.

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