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Original Article

Reduced parasympathetic tone in newly diagnosed essential hypertension

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ABSTRACT

Aim: The aim of the study was to compare heart rate variability (HRV) of newly diagnosed essential hypertensive subjects with controls.
Methods: The study was conducted on 120 hypertensive subjects and 120 controls.
Results: The time-domain measures, standard deviation of all RR intervals (SDNN), the square root of the mean of the sum of the squares of differences between adjacent RR intervals (RMSSD), and percentage of consecutive RR intervals that differ by more than 50 ms (pNN50) which reflect parasympathetic activity were significantly less in hypertensive subjects. In frequency-domain measures, high frequency [HF (ms^2)] and [HF (nu)], which reflects parasympathetic activity, was significantly less in hypertensive subjects while LF (nu) and LF/HF (%), which reflect sympathetic activity, were comparable between the groups.
Conclusion: These findings suggest that HRV is reduced in subjects with newly diagnosed essential hypertension and the parasympathetic dysregulation is present in the early stage of essential hypertension.

1. Introduction

Hypertension is defined as a persistent elevated blood pressure of ≥140/90 mmHg. Essential (primary) hypertension is the most common type of hypertension, affecting 95% of all cases of hypertension.[1] Hypertension is the most important preventable risk factor for premature death worldwide.[2] It can increase the risk of cerebral, cardiac, and renal events. Subtle target-organ damage, such as left-ventricular hypertrophy, microalbuminuria, and cognitive dysfunction, takes place early in the course of hypertensive cardiovascular disease while catastrophic events, such as stroke, heart attack, renal failure, and dementia, usually happen after long periods of uncontrolled hypertension only.[3] Thus, primary prevention of hypertension may reduce the overall risk of cardiovascular diseases.

Blood pressure is maintained physiologically by multiple mechanisms such as neural, hormonal, and local controls. Among them, neural control by autonomic nervous system (ANS) is the most important regulatory mechanism of blood pressure. Though hypertension is a multifactorial disease, ANS dysfunction is an important factor in the development and progression of hypertension.[4]

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Heart rare variability (HRV) is defined as the oscillation of heart rate around the mean value. A reduction in HRV is associated with an increased risk of cardiac mortality and has been shown to predict risk for cardiac events and overall mortality.[5] Studies have shown that changes in autonomic regulation of the cardiovascular system tend to occur before the manifestation of raised blood pressure.[6] Therefore, HRV analysis may provide important insights into the role of the autonomic nervous system in the pathogenesis of essential hypertension.[7] The purpose of this study was to compare the HRV of newly diagnosed essential hypertensive subjects with control subjects.

2. Research design and methods

2.1. Subjects

The study consisted of two groups: subjects with newly diagnosed hypertension and subjects without hypertension. Two hundred and forty male and female subjects between the age group of 30 and 50 years were recruited from the student and staff population of Nepalgunj Medical College, Banke. One hundred and twenty subjects with confirmed stage 1 hypertension (systolic pressure 140–159 and diastolic pressure 90–99), who had never been treated with a hypertensive medication for any indication, were the study group, and healthy age- and sex-matched one hundred and twenty normotensive subjects were the control group. The exclusion criteria were diabetes, secondary hypertension, obese, known history of chronic illness, and known neuropathy of any other etiology. In case of smokers and alcohol users, the subjects with the low nicotine and alcohol dependence were included.[8,9] The ethical clearance was obtained from the Ethics Committee of the College. All participants gave their written informed consent.

2.2. Clinical examination

All the subjects were subjected to clinical examination. Each participant underwent the measurement of his weight and height, recorded while wearing light indoor clothes but no shoes. Using a measuring tape, waist circumference (midway between the lower rib margin and the iliac crest) and hip circumference (the maximal circumference over the buttocks) were measured. Blood pressure was measured using standard protocol.

2.3. Heart rate variability

The ECG signals for HRV were recorded using electrocardiograph (Maestros Magic R Series) after a supine rest for 15 min. The resting ECG at spontaneous respiration was recorded for five min in supine position at chart speed 100 mm/s. From ECG, R-R intervals were measured manually with a ruler. Then these R-R intervals were saved as ASCII file. This format was readable by HRV analysis software 1.1 (Biomedical Signal Analysis Group, Department of Applied Physics, University of Kuopio, Finland). In this study, we analyzed HRV by three methods: time-domain, frequency-domain, and Poincare plot.

The time-domain analysis of HRV consisted of the standard deviation of all RR intervals (SDNN), the square root of the mean of the sum of the squares of differences between adjacent RR intervals (RMSSD), and pNN50, which is the percentage of consecutive RR intervals that differ by more than 50 milliseconds.[7]

The frequency-domain analysis of HRV consisted of the power of high frequency (HF), (0.15–0.40 Hz); low frequency (LF), (0.04–0.15 Hz); and very low frequency (VLF), (below 0.04 Hz) power ranges.[7]

It has been speculated that analysis of HRV based on the methods of nonlinear dynamics might elicit valuable information for the physiological interpretation of HRV. One nonlinear method is Poincare plot. The Poincare plot is a scatter plot of the current R-R interval plotted against the preceding R-R interval. Using the method described by Brennan,[10] these plots were used to extract indexes, such as length (SD2) and width (SD1) of the long and short axes of Poincare plot images.

2.4. Statistical analysis

Different anthropometric and cardiorespiratory variables were compared between the groups using Student independent *t*-test and data are presented as mean ± standard deviation. However, nonparametric Mann–Whitney *U* test was applied for comparisons of the HRV and the results are presented as median (interquartile range). A p value of <0.05 was considered statistically significant. Data were analyzed with statistical software IBM SPSS Statistics 21.

3. Results

3.1. Subject characteristics

Clinical characteristics of study participants are shown in Table 1. There was no significant difference between the groups in terms of their age, body mass index (BMI), and waist hip ratio. However, systolic blood pressure, diastolic blood pressure, pulse rate, and respiratory rate were significantly higher in hypertensive subjects compared with normotensive subjects.

3.2. Heart rate variability measures

3.2.1. Time-domain variables

The time-domain measures, SDNN, RMSSD, and pNN50 were significantly less in hypertensive subjects compared to normotensive subjects. Hypertensive women had higher time-domain measures compared to hypertensive men (Table 2).

3.2.2. Frequency-domain variables

The variables analyzed in frequency-domain measures included power of LF, HF, in ms^2 and normalized units (nu), and ratio of LF to HF (LF/HF). The LF power (ms^2), HF power (ms^2), and HF (nu) were significantly less in hypertensive subjects whereas LF (nu) and LF/HF ratio were comparable between the groups. Hypertensive women had higher HF (ms^2), HF (nu) and lower LF (ms^2) than hypertensive men (Table 3).