CLINICO-PHYSIOLOGIC SIGNIFICANCE OF HEART RATE VARIABILITY IN CHRONIC ISCHEMIC HEART DISEASE

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SUMMARY

The paper represents of the results of analysis of heart rate variability (HRV) in patients with chronic ischemic heart disease (IHD) in the context of search for informative characteristics for prognoses of IHD development and its end-points based on data of 297 healthy subjects and 4561 IHD patients (pts) (range of age was 20-84yr's). HRV was analyzed by means of calculation of HR power spectrum, HR responses to complex of tests (active orthostatic test, bicycle ergometry, night sleep), non-linear dynamics analysis methodology and baroreflex sensitivity. There was shown, that the pattern of HRV depend on level of development of IHD and its complications or leading pathology, having an impact to HR parameters due changes of mechanism and particular point of influence to HR autonomic control. The level of impact depends of the changes in cardiovascular functional state, particularly of development of congestive heart failure. HRV changes were dependent on increase of an impact of humoral-metabolic HR control due to depression of nervous reflex control, particularly parasympathetic one. Because of that, changes of HRV in IHD pts enable to follow the tendencies of development and treatment efficacy. As it was shown for myocardial infarction, in chronic IHD pts, there were possibility to use HRV characteristics, reflecting parasympathetic control, for cardiac death prognoses.

KEY WORDS: of heart rate variability, ischemic heart disease, cardiac death, prognoses, informative parameters

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RESPIRATORY SINUS ARRHYTHMIA (RSA): NONINVASIVE MEASURE OF PARASYMPATHETIC CARDIAC CONTROL IN NEWLY DIAGNOSED HYPERTENSIVES AND THE INFLUENCE OF ABDOMINAL BREATHING

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SUMMARY

Introduction: Respiratory sinus arrhythmia is a valuable tool for determining autonomic nervous system control of cardiovascular function and an important index of autonomic nervous system pathology

Objectives: The present study was conducted to compare the amplitude of respiratory sinus arrhythmia (expressed as Heart rate variability) in normotensive individuals and freshly diagnosed hypertensive subjects and to detect any influence of abdominal breathing in freshly diagnosed hypertensives

Materials and Methods: 50 Normotensive and 50 age matched hypertensive subjects were selected for the study.The subjects were instructed to breathe normally for first minute then during the second minute , subjects were requested to do conventional deep breathing using chest muscles (Intercostals chiefly). The subjects then performed abdominal breathing during the third minute, while electrocardiogram(ECG)in limb lead was being recorded and changes in heart rate was manually measured.

Results: The mean heart rate variability of newly diagnosed hypertensives was 6.30±1.11 for normal breathing, 12.48±1.64 for conventional deep breathing and 15.56±2.54 for abdominal breathing and mean heart rate variability of normotensive subjects was 8.10±2.25 ($P<0.0001$) for normal breathing,18.08±5.12 ($P<0.0001$) for deep breathing using chest muscles and 20.68±6.28 ($P<0.0001$) for abdominal breathing.

Discussion and Conclusion: The newly diagnosed hypertensive subjects had significantly reduced heart rate variability (amplitude of RSA) compared to age matched controls, which improved with abdominal breathing Thus the deleterious effect of reduced HRV can be revered to an extent through proper abdominal breathing in the hypertensive subjects as well as in controls as shown in our study.

KEY WORDS: heart rate variability, newly diagnosed hypertension, respiratory sinus arrhythmia, abdominal breathing

INTRODUCTION

In normal subjects the heart rate constantly alter from moment to moment. The most obvious variation in the rate is associated with breathing and appropriately named respiratory sinus arrhythmia with increase during inspiration and decrease during expiration. Wheeler and Watkins first suggested that the difference between maximum and minimum heart rate with deep breathing might serve as a clinical measure of cardiac vagal autonomic function [1]. Katona and Jih who in 1975 measured the heart period and respiratory sinus arrhythmia of anesthetized dogs while controlling vagal nerve activity by cooling and rewarming the cervical vagus nerve confirmed this observation. The authors demonstrated a linear relationship between parasympathetic control and the variation in heart period, thus supporting the use of magnitude of respiratory sinus arrhythmia as a non-invasive measure of parasympathetic cardiac control. This linear relationship was un changed by modifying vagal tone with alterations in blood pressure or by changes in cardiac sympathetic function induced by beta–adrenoreceptor blockade [2]. In an era of sophisticated tests of the autonomic system like Holter monitoring with an elaborate analytic system, including computerized power spectral analysis of heart rate variability, the purpose of this study was to evaluate a simple autonomic test (originally used to determine diabetic autonomic neuropathy) that compares the amplitude of respiratory sinus arrhythmia [Heart rate variability (HRV)] in normotensive and newly diagnosed hypertensive subjects. The present study in addition address to see whether the abdominal breathing brings any change in respiratory sinus arrhythmia.

MATERIALS AND METHODS

50 normotensive and 50 age matched hypertensive subjects (attending to K.M.C. Hospital, Attavar, Mangalore) aged 40-60 years were selected for the study.

Hypertensive Subjects (n=50):

Inclusion criteria: newly diagnosed hypertensive subjects

Exclusion criteria:

1) Diabetes mellitus
2) Congestive cardiac failure
3) Symptomatic coronary artery disease
4) Atrial fibrillation
5) Frequent ectopic beats

Normotensive Subjects:

50 healthy age matched normotensive control who fulfilled the following criteria were chosen as control subjects:

1) No signs of cardiac, vascular or neurological involvement.
2) No history of diabetes mellitus, hypertension.
3) No history of drug treatment.
4) No history of systemic illness.

In these subjects fasting blood sugar was investigated and conventional 12 lead ECG was taken.

Methods: For the purpose of this newly diagnosed hypertension (stage-1) was defined as systolic B.P of 140-159 mm of Hg and diastolic B.P of 90-99 mm of Hg or when systolic and diastolic pressure fell into different categories, the higher category being selected to classify the individual's blood pressure [5]. All subjects were clinically examined and detailed history was taken with reference to family history, personal history like smoking, alcoholic etc, previous drug history. Physical examination was done. Blood pressure was recorded in supine position. Three reading was taken and average of second and third was used for the study. BP was recorded after standing for two minutes to see for postural changes. Pulse rate, rhythm and character was also assessed. A clinical examination to exclude peripheral neuropathy was done. The following laboratory investigations were performed in all the hypertensive subjects i.e., fasting blood sugar, blood urea, serum creatinine, ECG in conventional twelve leads.

Method of test of heart rate variability: The key parameter in this study were heart rate variability (HRV) expressed by respiratory sinus arrhythmia based on the method described by originally Wheeler and Watkins (1973) and subsequently by Benett et.al. [3] and Mackay J D et.a.l [4]. The test was conducted with the subjects in supine position connected to the limb lead of a standard ECG. Subjects had to be in stabilized condition. This test was performed in the morning after the subjects had been in supine position for ten minutes. In the first minute, the subjects were instructed to do normal breathing to see the amplitude of respiratory sinus arrthymia then before beginning the conventional deep breathing test subjects were taught to breath at a rate of 6 respiration cycles/minute: 5 seconds for each inhalation and 5 seconds for each exhalation. A single examiner who raised his hand to signal the start of each inhalation and lowered it to signal the start of each exhalation performed the test. In the second minute the subjects were instructed to do conventional deep breathing

using chest muscles (intercostals chiefly) to see the maximum amplitude of RSA and then in third minute the subjects were instructed to do abdominal breathing where in the abdomen is pushed out during inspiration and drawn in during expiration, with diaphragm being the main muscle in action.ECG in lead two was then recorded continuously at a speed of 25 mm/second for three minutes, while the subject breathed as instructed. The R-R interval was measured manually with a scaled caliper. R-R intervals adjacent premature ventricular contractions were excluded from the analysis. The change in heart rate was calculated as the difference between the shortest and the largest R-R interval.

HRV = [1500 / Shortest R-R Interval (mm) – 1500 / Longest R-R Interval (mm)]
measured in beats/minute.

The 1 minute deep breathing heart rate variability test was chosen as a short bed side test based on the experience achieved in testing autonomic nervous control of the heart in patients with diabetes mellitus. On the basis of this study a test result was pre-specified normal if there was a difference of 8 beats or more per minute between shortest and the fastest heart for normal breathing. On the basis of the previous study , deep breathing test was pre-specified as normal if there was a difference of 15 beats or more per minute between shortest and the fastest heart (4).

Statistics: Student 't' test was used to compare the data of hypertensive and normotensive subjects. Mann-Whitney test was analyzed the heart rate variability(HRV) because 'F' test showed significant difference between standard deviation. P value <0.05 was considered statistical significant.

RESULTS AND DISCUSSION

The systolic and diastolic blood pressure was higher among hypertensive subjects than normotensive subjects (table 1).

Table 1

Shows Age, BMI (Body mass index), Systolic blood pressure, Diastolic blood pressure of hypertensive and normotensive subjects

	Normotensive subjects(n=50)	Hypertensive subjects(n=50)	P value
Age(yrs)	51.6± 9.5	51.6±9.7	0.188(N.S)
BMI(Kg/M^2)	22.6±1.1	22.3±1.17	0.284(N.S)
Sex (No)			
male	26(52%)	22(44%)	N.S
female	24(48%)	28(56%)	N.S
Blood pressure			
Systolic (mm of Hg)	120.86±8.34	146.19±12.22	<0.0001
Diastolic(mmof Hg)	82.0±4.73	93.33±8.66	<0.0001

Values are mean±SD

The mean values of HRV (amplitude of respiratory sinus arrhythmia) during normal breathing and conventional deep breathing using chiefly chest muscles were significantly lower in hypertensive subjects than in normotensive subjects (table 2).

The mean HRV during abdominal breathing was significantly lower in hypertensive subjects compared to controls (table 3).

Table 2

Shows mean HRV in hypertensive and normotensive subjects

	Normotensive subjects	Hypertensive subjects	P value
MeanHRV in normal breathing	8.10±2.25	6.30±1.11	<0.0001
Mean HRV during deep breathing	18.08±5.12	12.48±1.64	<0.0001

Values are mean±SD

Table 3

Shows the mean HRV during abdominal breathing in hypertensive and normotensive subjects

	Normotensive subjects	Hypertensive subjects	P value
Mean HRV	20.68±6.28	15. 56±2.54	<0.0001

The difference between the HRV (amplitude of respiratory sinus arrthymia) during normal, conventional deep and abdominal breathing was calculated for each member in the cases and controls. The HRV was significantly higher in conventional deep breathing and abdominal breathing compared to normal breathing in both cases and controls and the significance of HRV was higher in the abdominal breathing. There was significant difference in HRV between conventional deep breathing and abdominal breathing in hypertensive and normotensive subjects (table 4).

Table 4

Shows the difference between HRV (expressed as amplitude of RSA) during normal, conventional deep and abdominal breathing in newly diagnosed hypertensive and normotensive subjects

	Normotensive subjects	Hypertensive subjects	P value
Deepbreathing- normal breathing	5.94±4.42	3.36±2.26	<0.001
Abdominal breathing-normal breathing	9.58±5.68	6.08±2.79	<0.0001
Abdominal breathing-deep breathing	1.80±3.07	3.11±1.32	<0.05

Cardiac function is regulated by various intrinsic and extrinsic mechanisms. Heart rate is regulated mainly by the autonomic nervous system. Sympathetic nervous activity increases heart rate, whereas parasympathetic (vagal) activity decreases heart rate. When both systems are active, the vagal effects usually dominate. The following reflexes regulate heart rate: baroreceptor, chemoreceptor, pulmonary inflation, atrial receptor (Bainbridge) and ventricular receptor reflexes. The principal intrinsic mechanisms that regulate myocardial contraction are the Frank-Starling mechanism and rate-induced regulation [6].

Previous studies have shown that cardiovascular autonomic regulation is impaired in untreated or poorly controlled systemic hypertension but there has been limited information on HRV in systemic hypertension with abnormalities of autonomic regulation of heart rate [7,8]. To our knowledge, this is the first study that compares the heart rate variability(expressed as amplitude of RSA) during normal and conventional deep breathing between normotensive and hypertensive subjects. The maximum HR-minimum HR was used as a index in this study to measure RSA and hence parasympathetic cardiac control.

A) Our study clearly shows that hypertensives definitely have blunted parasympathetic cardiac control (expressed as RSA) compared to controls. Documented studies using RSA as an index of parasympathetic cardiac control for comparison of controls and hypertensives are few.

Drummond P.D studied the amplitude of RSA while breathing quietly in 32 normotensive controls and 28-hypertensive group. The amplitude of RSA in the hypertensive group was smaller [9].

Allicardine studied 13 un treated hypertensives and 10 normotensives. Average variation of heart rate period was used as an index of parasympathetic cardiac control. Controls were derived following pharmacological blockade of the sympathetic nervous system by propranolol and parasympathetic system with atropine. Results indicated diminished parasympathetic control of heart rate in hypertensives [10].

B) Sun F L and Yan YA had studied the effects of various quigong breathing (abdominal breathing) patterns on HRV and found that the 3 out of the 4 quigong modes could indirectly regulate the function of the viscera, including the heart by controlling the direct breathing patterns [11].

Cowan et.al. had analyzed HRV after the biofeedback training on 6 sudden cardiac arrest survivors. The physiological – theoretical basis of the training was cognitively inducing respiratory sinus arrhythmia. After a training period of 5 weeks, an increase in the respiratory driven parasympathetic activity was found, with a decrease in the sympathetic activity [12].

The present study also showed HRV (hence the parasympathetic cardiac control) was higher in abdominal breathing compared to normal and conventional deep breathing. Reduced heart rate variability(HRV) is associated with an increased risk of cardiac and overall mortality and the occurrence of life threatening arrhythmia's(8), So from this method the deleterious effect of reduce HRV to certain extent can be revered by abdominal mode of breathing.

CONCLUSION

The newly diagnosed hypertensives had reduced HRV (amplitude of RSA) compared to controls. Apparently, the parasympathetic activity increases with the abdominal mode of breathing in the hypertensives and controls. Long term studies are needed to see the effect of abdominal breathing on HRV and whether this can have any therapeutic value in the hypertensive patients.

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ДИХАЛЬНА АРИТМІЯ: НЕІНВАЗІВНИЙ ПОКАЗНИК ПАРАСИМПАТИЧНИХ ВПЛИВІВ НА СЕРЦЕ У ПАЦІЄНТІВ З УПЕРШЕ ВИЯВЛЕНОЮ АРТЕРІАЛЬНОЮ ГІПЕРТЕНЗІЄЮ, ВПЛИВ АБДОМІНАЛЬНОГО ПОДИХУ ДИХАННЯ

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РЕЗЮМЕ

Введення: Дихальна аритмія – це цінний інструмент для визначення впливу, що робиться вегетативною нервовою системою на серцево – судинну систему, а також важливий індекс, що відбиває патологію вегетативної нервової системи.

Ціль роботи: Порівняти амплітуду дихальної аритмії (вираженої в одиницях вариабельності серцевого ритму) у людей з нормальним артеріальним тиском і у людей із уперше виявленою артеріальною гіпертензією для виявлення впливу абдомінального подиху у людей із уперше виявленою гіпертензією.

Матеріали і методи: У дослідженні брали участь 50 здорових людей і 50 з уперше виявленою гіпертензією, групи мали ідентичний віковий і статевий склад. Під час першої хвилини дослідження учасники дихали вільно, під час другої хвилини подих був грудним, під час третьої хвилини – абдомінальним. Протягом усього дослідження робився запис ЭКГ і розрахунок показників вариабельностиі серцевого ритму (ВСР).

Результати: Середня ВСР у людей із уперше виявленою артеріальною гіпертензією складала 6,30±1,64 при вільному подиху, 12.48±1.64 при грудному подиху і 15.56±2.54 при абдомінальному подиху; середня ВСР у людей з нормальним артеріальним тиском складала 8.10±2.25(P<0.0001) при вільному подиху, 18.08±5.12 (P<0.0001) при глибокому грудному подиху і 20.68±6.28 (P<0.0001) при абдомінальному подиху.

Обговорення і висновки: У пацієнтів із уперше виявленою артеріальною гіпертензією спостерігається значне зниження ВСР (амплітуди дихальної аритмії) у порівнянні з групою контролю. Дані розходження зменшуються в умовах абдомінального подиху обстежуваних. Таким чином, негативний ефект зниженої ВСР у людей із уперше виявленою артеріальною гіпертензією може бути зменшений шляхом використання абдомінального подиху.

КЛЮЧОВІ СЛОВА: вариабельність серцевого ритму, уперше виявлена артеріальна гіпертензія, дихальна аритмія, абдомінальний подих

ДЫХАТЕЛЬНАЯ АРИТМИЯ: НЕИНВАЗИВНЫЙ ПОКАЗАТЕЛЬ ПАРАСИМПАТИЧЕСКИХ ВЛИЯНИЙ НА СЕРДЦЕ У ЛИЦ С ВПЕРВЫЕ ВЫЯВЛЕННОЙ АРТЕРИАЛЬНОЙ ГИПЕРТЕНЗИЕЙ, ВЛИЯНИЕ АБДОМИНАЛЬНОГО ДЫХАНИЯ

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РЕЗЮМЕ

Введение: Дыхательная аритмия – это ценный инструмент для определения влияния, оказываемого вегетативной нервной системой на сердечно–сосудистую систему, а также важный индекс, отражающий патологию вегетативной нервной системы.

Цель работы: Сравнить амплитуду дыхательной аритмии (выраженной в единицах вариабельности сердечного ритма) у лиц с нормальным артериальным давлением и у лиц с впервые выявленной артериальной гипертензией для обнаружения влияния абдоминального дыхания у лиц с впервые выявленной гипертензией.

Материалы и методы: В исследовании принимали участие 50 здоровых лиц и 50 лиц с впервые выявленной гипертензией, группы имели идентичный возрастно–половой состав. Во время первой минуты исследования участники дышали свободно, во время второй минуты дыхание было грудным, во время третьей минуты – абдоминальным. В течение всего исследования производилась запись ЭКГ и расчет показателей вариабельности сердечного ритма (ВСР).

Результаты: Средняя ВСР у лиц с впервые выявленной артериальной гипертензией составляла 6,30±1,64 при свободном дыхании, 12.48±1.64 при грудном дыхании и 15.56±2.54 при абдоминальном дыхании; средняя ВСР у лиц с нормальным артериальным давлением составляла 8.10±2.25($P<0.0001$) при свободном дыхании, 18.08±5.12 ($P<0.0001$) при глубоком грудном дыхании и 20.68±6.28 ($P<0.0001$) при абдоминальном дыхании.

Обсуждение и выводы: У лиц с впервые выявленной артериальной гипертензией наблюдается значительное снижение ВСР (амплитуды дыхательной аритмии) по сравнению с группой контроля. Данные различия уменьшаются в условиях абдоминального дыхания обследуемых. Таким образом, негативный эффект сниженной ВСР у лиц с впервые выявленной артериальной гипертензией может быть уменьшен путем использования абдоминального дыхания.

КЛЮЧЕВЫЕ СЛОВА: вариабельность сердечного ритма, впервые выявленная артериальная гипертензия, дыхательная аритмия, абдоминальное дыхание

УДК: 612.014:612.015.3

СОСТОЯНИЕ НЕЙРОГУМОРАЛЬНОЙ РЕГУЛЯЦИИ ЖИВОТНЫХ ПРИ ЭКСТРЕМАЛЬНЫХ ВОЗДЕЙСТВИЯХ

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РЕЗЮМЕ

С использованием технологии спектрального анализа вариабельности сердечного ритма выполнен сопоставительный анализ состояния нейрогуморальной регуляции в первые 20 минут после введения экстремальных доз (6 мг/кг) изадрина у 11 выживших и 7 погибших кроликов. Показано, что для погибших характерна исходно более высокая мощность и более значимый ее рост в первые 5 минут после воздействия. Реакция со стороны парасимпатического домена у этих животных, напротив, характеризуется снижением его мощности. Вся регуляция у погибших животных как бы концентрируется в гуморальном звене. Состояние нейрогуморальной регуляции у выживших животных нормализуется в течение первых суток после воздействия.

КЛЮЧЕВЫЕ СЛОВА: вариабельность сердечного ритма, изадрин, экстремальные воздействия

ВВЕДЕНИЕ

С состоянием регуляции связывают понятия адаптации, резервов здоровья, способности противостоять болезням и шансы умереть [4, 14]. Внедрение во врачебную практику компьютерных технологий контроля регуляторных систем, основанных на спектральном анализе вариабельности сердечного ритма (СА ВСР), создало реальные предпосылки для их практических приложений в оценке устойчивости организма к действию экстремальных факторов различной природы [3, 5, 10, 11, 15]. Настоящее исследование решало задачу оценки состояния нейрогуморальной регуляции в остром периоде после экстремального воздействия.

МАТЕРИАЛЫ И МЕТОДЫ

Опыты поставлены на 18 кроликах-самцах породы Шиншилла массой тела от 2,2 до 2,8 кг, содержавшихся в стандартных условиях вивария. В качестве экстремального воздействия использовали нагрузку β-симпатомиметиком изадрином: однопроцентный раствор подкожно однократно в дозе 6 мг/кг массы тела. По результатам экспериментов погибло 7 животных. Смерть наступала в первые 12-27 минут после нагрузки изадрином. Использованная нагрузка критическими дозами изадрина – естественная модель разрешения чрезмерных влияний самой разной природы и потому удовлетворяет решению поставленной задачи.