The Heart Frequency and Its Variability in Hypertensive Patients Considering A/B Type of Behaviour and Eight Basic Emotions and Levels of Anger Expression

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ABSTRACT

The aim of this paper was to comparison between autonomic regulation of the heart rate and it’s variability within 100 essential hypertensive patients and 100 examinees in healthy control group. Essential hypertensive patients had significantly shorter average RR interval, that is, faster heart frequency then the control group. Average variability of the heart frequency was statisticaly considerably lower in hypertensive than in the healthy control group. Sistolic blood pressure, diastolic blood pressure, duration of hypertension, levels have considerate total influence on heart frequency and it’s variability during calm and during deep breathing. The most distinctive negative connection was found between variability of the heart frequency and duration of hypertension. The type A behaviour within hypertensive patients and the control group was more common then type B. In the hypertensive group, total influence of all independent Bortner’s variables on to variability of the heart frequency during calm breathing was statisticaly important. Within hypertensive patients and the control group, the heart frequency and it’s variability were connected with eight basic emotions. In the group of hypertensive patients variability of the heart frequency is significantly positively connected with emotional dimension »Incorporation«, but negatively with emotional dimensions »Protection«, »Rejection« and »Reproduction«. Our data showes that patients with long-term hypertension have increased heart frequency and reduced variability of the heart frequency, which are well-known risk factors for increased cardial mortality.

Key words: hypertensive patients, A/B type of behaviour, basic emotions

Introduction

It is estimated that 15–20% of adult population in industrialized high-developed countries, as well as in Croatia17 in the world have high blood pressure16. For adults, hypertension is considered to be with sistolic blood pressure equal or higher than 21.3 kPa, and/or diastolic equal or higher then 12.0 kPa. Untreated hypertension increases appearance of heart failure, coronary heart disease, haemorrhagic and trombthic stroke, renal insuficiency, aortal dissection and death2–5. Diagnosed hypertension is psychological and socioeconomic burden to a patient because it almost always demands life-long therapy8–10. In arterial hypertension, the heart, at first, shows signs of hyperkinetic syndrome. The heart frequency is normally determined by early diastolic depolarization of the nodus sinoatrialis (heart automatism), function of the automatic nervous system, body temperature, thyroid hormones, metabolism, catecolamines and neurotransmiters22. Numerous studies confirmed that average heart

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frequency is considerably higher in hypertensive than in
those normotensive individuals, however it’s not signifi-
cantly connected to hypertensive cardiomyopathy28.

Emotional state, i.e. neurogenic factors, affect many
functions of cardiovascular system. Heart frequency, blood
pressure, peripheral blood vessels succumb to quick chan-
ges due to stimulus from autonomic nervous system32,33.
There are two types of behaviour, A and B34. Fully de-
veloped typ A connotes readiness, impatience, intolerance,
aggressive and hostile attitude, competitive spirit and con-
stant personal ambition. In other words, type A is emo-
tional complex that can be attributed to individuals in
constant struggle to accomplish as much as they can in
the shortest of time, or they are in constant conflict with
people from their surroundings. Unlike this, type B is
mostly released of these features, has no conflict with time
and people, therefore no hostility.

According to Plutcnik, there are eight basic or primal
emotions which are foundation for reactions of adults. 3
positive emotions are: acceptance (incorporation), joy
(reproduction), anticipation (exploration), and 5 negative
are, disgust (rejection), sadness (deprivation), fear (pro-
tection), surprise (orientation) and anger (destruction). They
have adaptational meaning for survival of individuals.

The purpose of our study was to analyze autonomic
regulation of heart function in relation to type of behavior,
eight basic emotions and Minnesota scale anger through
frequency and it’s variability in hypertensive patients
compared to healthy individuals.

Material and Methods

This study was performed at the cardiovascular infir-
mary of Internal Clinic in Clinical Hospital Osijek, with
the approval of the hospital Ethical Committee. For the
group of examinees we chose only those hypertonics in
which we did not found detectable secondary reason of
high blood pressure and it’s complications. Hypertensive
patients with angina pectoris, myocardial infarction, val-
vular heart disease, congestive heart disease, diabetes
mellitus, renal insufficiency, obstructive lung disease and
musculosceletal disorder had been excluded from the re-
search. One hundred examinees, 40 men of average age
of 47.1 ± 8.6 years old and 60 women of average age of
50.7 ± 7.0 years old made the hypertensive group. A con-
tral subjects were matched by gender, age and marital
state from the normotensive healthy individuals who vis-
it Internal Clinic or Institute of Public Health Osijek
for some other reason. Every examinee, gave detailed
medical anamnesis, physical status was taken, blood
pressure, height and weight were measured, also body
mass index was calculated.

After laying down and resting for 15 minutes, 12 lead
electrocardiograph and paper rhythm of 100 R-R inter-
vals (variability of the heart frequency) has been re-
corded during calm slow breathing and deep breathing.
R-R intervals have been measured in order, with a pair of
compasses. The variability of R-R intervals (variability
od heart frequency) was expressed by coefficient of vari-
ability (CV) for 100 R-R intervals during calm and during
depth breathing. By definition, deep breathing is a state in
which a patient breathes freely and as deep as possible,
with a frequency of 6 inhales per minute44.

Each examinee filled in Bortner’s scale to determine
type of behavior, A or B with a physician’s help. Maxi-
mum score is 336 points. Total count of 169 to 336 points
have individuals that belong to A type behaviour, while
168 or less points indicate a person with B type beha-
vour45,46. Also an EMOTIONS PROFILE INDEX (EPI)
according to Plutchik was made for every examinee.
That is a personality test formed to give informations
about basic personality types and intrapersonal conflicts
in life of every individual47. It’s composed of 12 terms
which are joined in pairs in every possible combination.
So, we get 62 tasks in which an examinee is «forced» to
chose one term in pair which describes him the most. For
example, «Is he more shy or dispirited?». Selection is
marked in a sence of emotions which are implied in cho-
osen word, for example, shyness implies fear, while con-
sternation implies sadness. Rough results of emotional
dimension are expressed through frequentional table
which adequate percentage for every emotional dimen-
tion. This test measures intensity, analogy and bipolarity
of eight basic emotions. Intensity of an emotion is shown
with a scale from 0 to 100%. Percentage beyond 60% is
considered high, and one below 40% low.

An examinee’s anger level control was tested with
Minnesota multiphasal personal scale of anger expres-
sion. That is a question-form with 16 statements on
which are answered with «yes» or «no». If the number of
affirmative answers is lower, examinees are better in
control of their anger. So, lower rating anger is repre-
sented with 0–1, middle rating 2–4, higher rating 5–16
affirmative answers50,51.

Statistical analysis

Data are represented as average value and standard
deviation. Statistical significance was determined by Stu-
dent’s t-test between groups, variance analysis and $\chi^2$-test.
Mutual cohesion between variables were determined by
linear correlation coefficient ($r_{xy}$ = $\frac{SD_{xy}}{SD_{x}SD_{y}}$). Cohes-
ion strength in between of depended variable and inde-
pendent variables was determined by multiple regression
coefficient and beta coefficient. Statistical importance of
results was defined on the level $p<0.05$.

Results

Heart frequency and it’s variability
during calm and deep breathing

Within the group of hypertonics, during calm breath-
ing, average R-R interval was shorter, that was higher
heart rate then within control group (758.7 ± 29.3 ms op-
posite 824.9 ± 38.4 ms), which was of statistical impor-
tance ($t$-test = –4.031, df = 99, $p<0.05$). Equally, average
frequency variability was statistical distinctively lower in
the group of hypertonics, than in the control group (t-test = –2.394, df = 99, p<0.05).

During deep breathing R-R interval was shorter than in calm breathing. The heart frequency was higher in the group of hypertonics than in control group (726.7 ± 40.3 ms opposite 779.0 ± 49.5 ms), what was also of statistical importance (t-test = –3.507, df = 99, p<0.05). Equally, average frequency variability was statistical distinctly lower in the group of hypertonics, than in control group (t-test = –2.095, df = 99, p<0.05).

**Somatic factors and their correlation with heart frequency ant it’s variability**

An average weight within the group of hypertonics was 80.0 ± 15.1 kg, and within the control group was 70.5 ± 11.6 kg, which is of statistical importance (t-test = 4.97, df = 198, p<0.05). An average height in hypertonics was 170.3 ± 8.8 cm, and within the control group was 170.3 ± 8.5 cm. Body mass index (BMI) in the group of hypertonics was 27.4 ± 3.8 kg/m², and in the control group was 24.2 ± 3.1 kg/m². That difference had statistical importance (t-test = 6.44, df = 198, p<0.05).

75 examinees from the group of hypertonics and 51 examinees from the control group had positive family history for hypertension, which made statistically important difference (χ² = 11.35, df=1, p<0.05).

A connection between length of average R-R interval, during calm and during deep breathing and coefficient of variability (CV) of R-R interval (heart frequency variability) with altitude of sistolic and diastolic blood pressure and duration of hypertension had been tested with multiple regresion analysis in the group of hypertonics. We found that total influence of independent variables on R-R interval length in calm (multiple regression coefficient R = 0.569, p<0.05), and in deep breathing (multiple regression coefficient R = 0.558, p<0.05) was statist-
cally important. Also, effect of all independent variables on coefficient of variability (CV) of the R-R interval (variability of the heart frequency) during calm breathing was statistically important (multiple regression coefficient R = 0.989, p<0.05). Coefficient of variability (CV) of the R-R interval during deep breathing was also statistically important and negative connected with duration of hypertension (beta =–0.291, p<0.05). A total influence also showed statistical significance (multiple regression coefficient R=0.975, p<0.05) (Table 1).

**Types of behaviour and their connection with heart frequency and it’s variability**

In the group of hypertonics A type behaviour was present within 63 examinees, and in the control group within 69 examinees (no statistically important difference).

A connection between average R-R interval during calm and during deep breathing and coefficient of variability (CV) of R-R interval (variability of the heart frequency) and type of behaviour and every individual Bortner’s item was examined with multiple regression analysis.

It shows that, within control group, there’s statistically important total influence of all independent variables on to length of average R-R interval during deep breathing (multiple regression coefficient R=0.561, p<0.05). Statistically important influence on to multiple regression coefficient have items which asses »Tension« (beta=–0.508, p<0.05), »Expression of emotions« (beta=–0.314, p<0.05), total »Bortner« (beta=–0.200, p<0.05) and »Impetuosity« (beta=0.324, p<0.05) (Table 2).

Within the group of hypertonics influence of all independent variables on to coefficient of variability (CV) of R-R interval during calm breathing is statistically important (multiple regression coefficient R=0.509, p<0.05) (Table 3).

**Profile index of eight basic emotions and its connection to heart frequency and it’s variability**

In the group of hypertonics, emotional dimensions like »Incorporation« and »Reproduction« showed relative intensity above average (more than 60%), while »Rejection« and »Destruction« were below average relative intensity (less than 40%). In the control group, emotional dimensions »Rejection« and »Destruction« were above, and »Rejection« and »Exploration« were below average. »Rejection« as an emotional dimension was statistically importantly lower in the group of hypertonics (t-test =–2.066, df = 99, p<0.05), while an emotional dimension »Exploration« in hypertonics was statistically importantly higher than in the control group (t-test = 2.986, df = 99, p<0.05). In between the group of hypertonics and the control group, there were no statistically important difference in relative intensity of other emotional dimensions.

A connection between an average R-R interval, during calm and during deep breathing, and coefficient of variability (CV) of the R-R interval (variability of the heart frequency) and Plutchik’s eight basic emotions was tested with multiple regression analysis.

In the control group, total influence of all independent variables on to coefficient of variability (CV) of the R-R interval (variability of the heart frequency) during calm breathing was statistically important (multiple regression coefficient R=0.518, p<0.05).

### Table 3: A Connection between R-R Interval and Coefficient of Variability (CV) of R-R Interval and Bortner’s Type of Behaviour in the Group of Hypertonics

<table>
<thead>
<tr>
<th>Bortner scale (type of behaviour)</th>
<th>Beta coefficient of R-R interval (calm breathing)</th>
<th>Beta coefficient of CV R-R interval (calm breathing)</th>
<th>Beta coefficient of R-R interval (deep breathing)</th>
<th>Beta coefficient of CV R-R interval (deep breathing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punctuality</td>
<td>–0.04</td>
<td>0.14</td>
<td>–0.07</td>
<td>0.14</td>
</tr>
<tr>
<td>Competitive spirit</td>
<td>–0.04</td>
<td>0.21</td>
<td>–0.08</td>
<td>0.12</td>
</tr>
<tr>
<td>Disobedience</td>
<td>0.04</td>
<td>0.18</td>
<td>0.09</td>
<td>–0.20</td>
</tr>
<tr>
<td>Haste</td>
<td>0.40</td>
<td>0.18</td>
<td>0.41</td>
<td>–0.01</td>
</tr>
<tr>
<td>Impatience</td>
<td>–0.19</td>
<td>0.18</td>
<td>–0.16</td>
<td>0.06</td>
</tr>
<tr>
<td>Insecurity</td>
<td>–0.06</td>
<td>–0.02</td>
<td>–0.05</td>
<td>–0.12</td>
</tr>
<tr>
<td>Doing several things simultaneously</td>
<td>0.03</td>
<td>–0.02</td>
<td>0.05</td>
<td>–0.15</td>
</tr>
<tr>
<td>Impetuosity</td>
<td>–0.36</td>
<td>0.14</td>
<td>–0.37</td>
<td>0.05</td>
</tr>
<tr>
<td>Wish for acknowledgement</td>
<td>–0.11</td>
<td>–0.14</td>
<td>–0.05</td>
<td>–0.14</td>
</tr>
<tr>
<td>Promptitude</td>
<td>–0.04</td>
<td>–0.26</td>
<td>–0.03</td>
<td>–0.02</td>
</tr>
<tr>
<td>Tension</td>
<td>0.10</td>
<td>0.06</td>
<td>0.07</td>
<td>0.06</td>
</tr>
<tr>
<td>Expression of emotions</td>
<td>–0.10</td>
<td>0.04</td>
<td>–0.12</td>
<td>–0.25</td>
</tr>
<tr>
<td>Several interest</td>
<td>–0.16</td>
<td>–0.19</td>
<td>–0.11</td>
<td>–0.25</td>
</tr>
<tr>
<td>Ambition</td>
<td>–0.13</td>
<td>–0.14</td>
<td>–0.10</td>
<td>–0.14</td>
</tr>
<tr>
<td>TOTAL</td>
<td>–0.222</td>
<td>–0.046</td>
<td>–0.143</td>
<td>–0.033</td>
</tr>
</tbody>
</table>

Multiple regression coefficient 0.452 0.434 0.509 0.460.
cally breathing (multiple regression coefficient R=0.396, p<0.05) was statistically important, to which emotional dimensions »Incorporation« (beta=1.575, p<0.05), »Exploration« (beta=1.274, p<0.05) and »Destruction« had the most important positive contribution, while emotional dimensions »Protection« (beta =–0.821, p<0.05), »Rejection« (beta =–0.802, p<0.05) and »Reproduction« (beta =–1.031, p<0.05) negatively contributed the most (Table 4).

In the group of hypertensics, statistically important was total influence of all independent variables on length of average R-R interval (multiple regression coefficient R=0.484, p<0.05) and coefficient of variability (CV) of R-R interval (multiple regression coefficient R=0.429, p<0.05) during deep breathing. CV of R-R interval was importantly positively connected to emotional dimension »Incorporation«(beta=1.198, p<0.05), and importantly negatively connected to emotional dimensions »Protection« (beta=–1.077, p<0.05), »Rejection«(beta=–1.096, p<0.05) and »Reproduction«(beta=–1.509, p<0.05) (Table 5).

Difference in anger level between the group of hypertensics and the control group was small and wasn’t statistically important (\(\chi^2 = 1.67, \text{df}=2, p>0.05\)).

**Discussion**

In this study we studied autonomic regulation of the heart function, threw heart frequency and it’s variability expressed by coefficient of variability in 100 sequential heart beats recorded by the EKG during calm and deep breathing, within 100 patients with essential hypertension and compared it to 100 healthy examinees in the control group. 75% of hipertonics had a positive family
A body weight and a body mass index (BMI) were considerably higher in hypertensives than in the control group. According to data from literature, there’s positive correlation between increased body weight and hypertension.

Many epidemiologic studies of essential hypertension showed increased sympathetic activity, especially in the early phase of hypertension\(^63,64\). Heart frequency in hypertensives has positive connection with cardiovascular morbidity and mortality. With higher heart rate, cardiovascular morbidity and mortality increases\(^65-67\). Patients with essential hypertension, in our research, had considerably higher heart frequency at rest and during deep respiration than the control group. R-R variability at rest and during deep respiration was considerably lower in hypertensives than in the control group, which goes in favour of increased sympathetic activity, while vagal activity is reduced. A smaller increase in RR variability was found in hypertensive patients than in the control group during deep breathing.

A coefficient of variability calculated from standard deviation of the RR interval is useful clinical indicator of cardiac parasympathetic activity\(^70,71\). A mechanism of decreased parasympathetic activity in the essential hypertension is connected with abnormal autonomic stimulation of normal sinal node or abnormal function of the beta-receptors. A beta-adrenergic hypersensitivity syndrome has been described\(^72\).

A variability of heart frequency in hypertensives with left ventricle hypertrophy was significantly reduced considering the control group, which is already confirmed in some earlier studies\(^30,73,74\). A number of hypertensives with heart changes in our research was considerably lower than the number of those hypertensives without heart changes. Sistolic pressure, diastolic pressure, duration of hypertension, have total considerable influence on the heart frequency and it’s variability. The most significant negative connection is found between variability of the heart frequency and duration of hypertension. Some recent studies showed that low variability of the heart frequency is a predictor of cardiac events such as myocardial infarction, rapid progression of atherosclerosis and death after myocardial failure\(^75,76,77\).

In hypertensives and in the control group «A» type behaviour was prevailing, but difference was not statistically important. That result could be explained with socioeconomic milieu and present period of «society in transition» in which we live today. Type A of behaviour is related to heart frequency and it’s variability. In the hypertensive group, total influence of all independent variables on variability of the heart frequency during calm breathing was statistically important. The heart frequency is considerably negatively influenced by items which assess «tension», «expression of emotions» and «total Bortner», and positively by «impetuosity». The type A behaviour is associated with increased heart frequency and it’s variability in both groups.

An anger level was high within 65% of hypertones. In the control group, 60% of examinees had high anger level, but difference was not statistically important. Some data from literature inform about connection between suppressed anger and high blood pressure. Haynes and associates and Goldberg didn’t find constant connection between anger and blood pressure\(^50,81\). Anger can be result of psychosocial stress which is associated with hypertension or it’s aggravation\(^82,83\).

In «Emotion profile», regarding the control group, hypertensive individuals had significantly lower emotional dimension «Rejection», and higher emotional dimension «Exploration». These data says that hypertensive individuals are more uncritical and unable to relax than individuals in the control group. According to the literature available to us, Plutchik’s «Emotion profile» was rarely used in hypertensive patients. Čatipović-Veselica and associates did not find significant difference in average emotion profile between hypertensive and normotensive workers\(^84\).

Our data shows that patients with hypertension have increased heart frequency and reduced variability of the heart frequency. Increased heart frequency and reduced variability of the heart frequency in patients with long-term hypertension can contribute to progression of cardiac morbidity and mortality. The question is whether to use medicaments or non-medicament methods to improve variability of the heart frequency.

1. The method of measuring hundred sequential heart beats on EKG, during rest and during deep breathing, showed to be sensitive and simple diagnostic measure of decreased function of the parasympathetic nervous system in essential arterial hypertension. Coefficient of variability calculated from standard deviation of RR interval is useful clinical indicator of cardiac parasympathetic activity in essential hypertension.

2. Patients with essential arterial hypertension had significantly higher heart frequency at rest and during deep breathing then the control group. Variability of the heart frequency, at rest and during deep breathing, was considerably lower in hypertensive patients then in the control group, which goes in favour of increased sympathtetic activity, and reduced vagal activity.

3. A body mass and a body mass index (BMI) were considerably higher in examinees with essential arterial hypertension. Sistolic blood pressure, diastolic blood pressure, duration of the hypertension, have significant total influence on the heart frequency and it’s variability. Variability of the heart frequency is negatively associated with duration of hypertension.

4. Within examinees and controls prevailed «A» type behaviour. Items which assess «tension», «expression of emotions» and «total Bortner» had negative considerable influence on the heart frequency but «Impetuosity» had positive influence.

5. Eight basic emotions according to Plutchik influence the heart frequency and it’s variability. Hypertens-
sive patients were more uncritical and more unable to re-
lax then the control group.

6. Our results show that patients with hypertension
have increased heart frequency and reduced variability
of the heart frequency, which are well known risk factors
for increased cardial morbidity and mortality. This raises
the quasion of therapeutic approach to the patient with
essential hypertension, medicamentous treatment or so-
me other methods like psychosocial to increase variabil-
ity of the heart frequency.

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1. HUMERFELT SB, Acta Med Scand 401 (1963) 1. — 2. YOSEFY C,
U ovom radu istraživali smo autonomnu regulaciju rada srca putem frekvencije srca i njene varijabilnosti kod 100 bolesnika s esencijalnom hipertenzijom i uspoređili sa 100 ispitanika zdrave kontrolne grupe. Bolesnici s esencijalnom hipertenzijom imali su značajno kraći prosječni RR interval, odnosno bržu frekvenciju srca nego kontrolna grupa. Prosječna varijabilnost frekvencije srca je statistički značajno niža u hipertenzivnoj, nego u zdravoj kontrolnoj grupi. Na frekvenciju srca i njenu varijabilnost ukupno značajno utječu, pri mirnom i dubokom disanju: sistolički tlak, dijastolički tlak, masa lijevog ventrikula, dijastolička disfunkcija lijevog ventrikula, veličina lijevog atrija, trajanje hipertenzije, visina kolesterol i triglicerida. Najznačajnija negativna povezanost nađena je između varijabilnosti frekvencije srca i trajanja hipertenzije. U hipertenzivnih bolesnika i u kontrolnoj grupi češći je »A tip« nego »B tip« ponašanja. U hipertenzivnoj grupi statistički je značajan ukupan utjecaj svih nezavisnih varijabli po Bortneru na varijabilnost frekvencije srca pri mirnom disanju. Frekvencija srca i njena varijabilnost povezane su sa osam temeljnih emocija kodu hipertenzivnih ispitanika i kontrolne skupine. U grupi hipertenzivnih bolesnika varijabilnost frekvencije srca značajno je pozitivno povezana s emocionalnom dimenzijom »Inkorporacija«, a negativno s emocionalnim dimenzijama »Zaštita«, »Odbacivanje« i »Reprodukcija«. Naši podaci pokazuju da bolesnici s dugotrajnom hipertenzijom imaju povišenu frekvenciju srca i reducirana varijabilnost frekvencije srca, što su poznati čimbenici rizika za povišani kardijalni mortalitet.