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RELATIONSHIPS BETWEEN Ca/K PLASMA RATIO AND PARAMETERS OF HEART RATE VARIABILITY AT PATIENTS WITH DIATHESIS URICA

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Abstracts

Background. Previously we shown that Kerdö’s Vegetative Index is not marker of sympatho-vagal balance, but reflects above all Amplitude of α-Rhythm EEG and its Power Spectrum Density in Parietal and Central loci, less options HRV. The aim of present study is analyze the relationships other marker of sympatho-vagal balance Ca/K Plasma Ratio with parameters of HRV. **Methods.** In basal conditions in twentee volunteers – ten women add ten men aged 33-76 years with diathesis urica recorded Heart Rate Vatiability (HRV) (“Cardiolab+VSR”, KhAI Medica, Ukraine). In blood plasma measured the concentration of Calcium and Potassium. **Results.** No correlation ascertained between Ca/K Plasma Ratio and LF/HF Ratio (r=-0,07) and LFnu (r=0,09). However, Ca/K Plasma Ratio moderately negatively correlated with vagal markers: SDNN (r=-0,30), RMSSD (r=-0,34), pNN_{50} (r=-0,36), HRV TI (r=-0,34), absolute PS HF (r=-0,33) and positively with sympathetic marker Amplitude of Moda (r=0,24 for actual values and 0,38 for portion of age norm) as well as with relative PS ULF (r=0,39). The strongest correlations of Ca/K Plasma Ratio proved with absolute PS LF (r=-0,45) and variational sweep: r=-0,42 for actual values and -0,49 for portion of age norm. Canonical correlation between Ca/K Plasma Ratio, on the one hand, and the parameters of HRV, on the other hand, is strong: R=0,713; R^2=0,509; Adjusted R^2=0,437; $F_{(5,3)}$=7,0; $\chi^2_{(5)}$=25,2; $p=10^{-4}$. **Conclusion.** Ca/K Plasma Ratio reflects inversely vagal tone and less direct sympathetic tone, therefore is really marker of sympatho-vagal balance.

Keywords: Ca/K Plasma Ratio, HRV, correlations.

INTRODUCTION

Previously we showed that the vegetative index Kerdoe, calculated on the basis of frequency rate and diastolic blood pressure, contrary to tradition, is not a marker sympatho-vagal balance [2]. It has long been known another marker tone of the autonomic nervous system - the ratio K/Ca in serum. It is believed that improving potassium corresponds to vagus stimulation effect or action of acetylcholine, while increasing the level of calcium in the blood stimulates sympathicus [5]. Popovych IL [9] applied this indicator in the battery of tests to assess stress levels in rats for the convenience transforming it into $(Ca/K)^{0,5}$ Ratio. The goal of this study - to analyze correlations $(Ca/K)^{0,5}$ Ratio with parameters Heart Rate Vatiability (HRV).

MATERIALS AND METHODS

The study involved twenty volunteers – ten women add ten men aged 33-76 years with diathesis urica. In the morning, seated in each ECG recorded for 7 min, using hardware-software complex " КардиоЛаб+ВСР" (ХАИ-МЕДИКА, Kharkiv, Ukraine) in standard lead II [1,10,11]. In sample of plasma of venous blood measured levels of Calcium (by a reaction with arsenazo III) and Potassium (by the method of flaming photometry) according to instruction [3] with use the analyzers “Reflotron” (USA) and “СФ-46” ПФМУ (URSS). After 7 days ECG recording and elecrtolytes measuring repeated. For further analysis the following parameters heart rate variability (HRV) were selected. Temporal parameters (Time Domain Methods): the standart deviation of all NN intervals (SDNN); the square root of the mean of the sum of the squares of differences between adjacent NN intervals (RMSSD); the percent of interval differences of successive NN intervals greater then 50 ms (pNN_{50}); triangulary index (TI); heart rate (HR); moda (Mo); the amplitude of moda (AMo); variational sweep (Delta X). Spectral parameters (Frequency Domain Methods): absolute (in ms^2) and relative (% of total) power spectral density (PSD) components of HRV - high-frequency (HF, range 0,4÷0,15 Hz), low frequency (LF, range 0,15÷0,04 Hz), very low frequency (VLF, range 0,04÷0,015 Hz) and ultra low frequency (ULF, range 0,015÷0,003 Hz). Expectant as classical indexes: LF/HF, LFnu=100%•LF/(LF+HF) and Baevskiy Stress Index (SI=AMo/2•Mo•DX) [1].

For statistical analysis applied doubles, regression and canonical correlation analysis using the software package "Statistica 5.5" [9].

RESULTS AND DISCUSSION

According to the summary and recommendations of the Task Force [4] for interpretation of HRV components, vagal activity is the major contributor to the HF component. Time domain variable approximate correspondences HF (RMSSD, pNN_{50}) or total power (SDNN, HRV TI). Disagreement exists in respect to the LF component. Some studies suggest that LF, when expressed in normalized units, is quantitative marker of sympathetic modulations; other studies view LF as reflecting both sympathetic activity and vagal activity. Consequently, the LH/HF ratio is considered by some investigators to mirror sympathovagal balance or to reflect the sympathetic modulations. Physiological interpretation of VLF (0,04÷0,003 Hz) and ULF (≤0,003 Hz) components of HRV warrants further elucidation.

There is speculation that the formation of oscillation in the range of 0,007÷0,003 Hz associated with the activity of the hypothalamic centers suprasegmentary autonomic regulation that generate rhythms transmitted to the heart via the sympathetic nervous system. Assume the

relationship VLF rhythms of thermoregulation, asked hypothalamus. Discovered rhythms associated with oscillation blood level of renin (0,04 Hz), epinephrine (0,025 Hz), norepinephrine (0,002 Hz), 17-OCS (0,0019 Hz) [8].

There is also speculation that LF (0,14÷0,06 Hz) component of HRV is linked to the operation of baroreflex mechanism, whereas the VLF (0,06÷0,01 Hz) component of HRV associated with changes in sympathetic activity [7].

We detected relationships between the parameters HRV and background EEG activity in healthy men [11] as well as in patients suffering from chronic renal pathology [10].

According to calculations by the formula [10]:

$|r|=\{\exp[2t/(n - 1,5)^{0,5}] - 1\}/\{\exp[2t/(n - 1,5)^{0,5}] + 1\}$

for a sample of n=40 critical value |r| at $p<0,05$ ($t>2,00$) is 0,31.

Contrary to expectations, no correlation ascertained between Ca/K Plasma Ratio and LF/HF Ratio (Fig. 1) as well as LFnu (r=0,09).

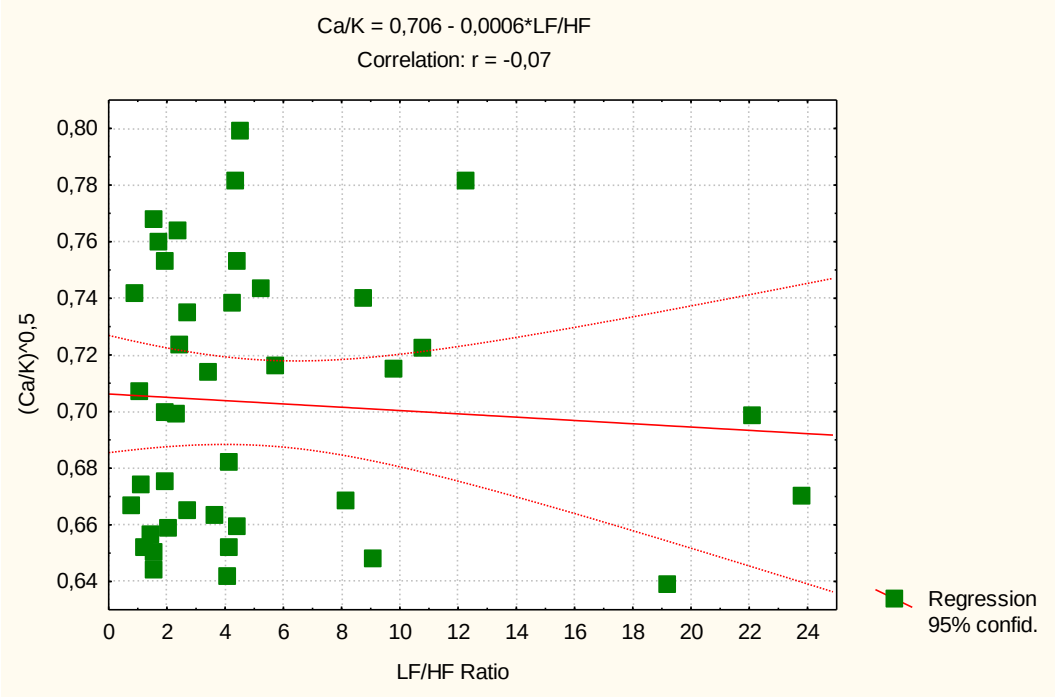

Fig. 1. Correlation between LF/HF HRV Ratio (axis X) and Ca/K Plasma Ratio (axis Y)

However, Ca/K Plasma Ratio moderately negatively correlated with vagal markers SDNN (r=-0,30), RMSSD (r=-0,34), pNN_{50} (r=-0,36), HRV TI (r=-0,34) and absolute PS HF (r=-0,33).

The strongest correlations of Ca/K Plasma Ratio proved with absolute PS LF (Fig. 2) and actual values of variational sweep (Fig.3).

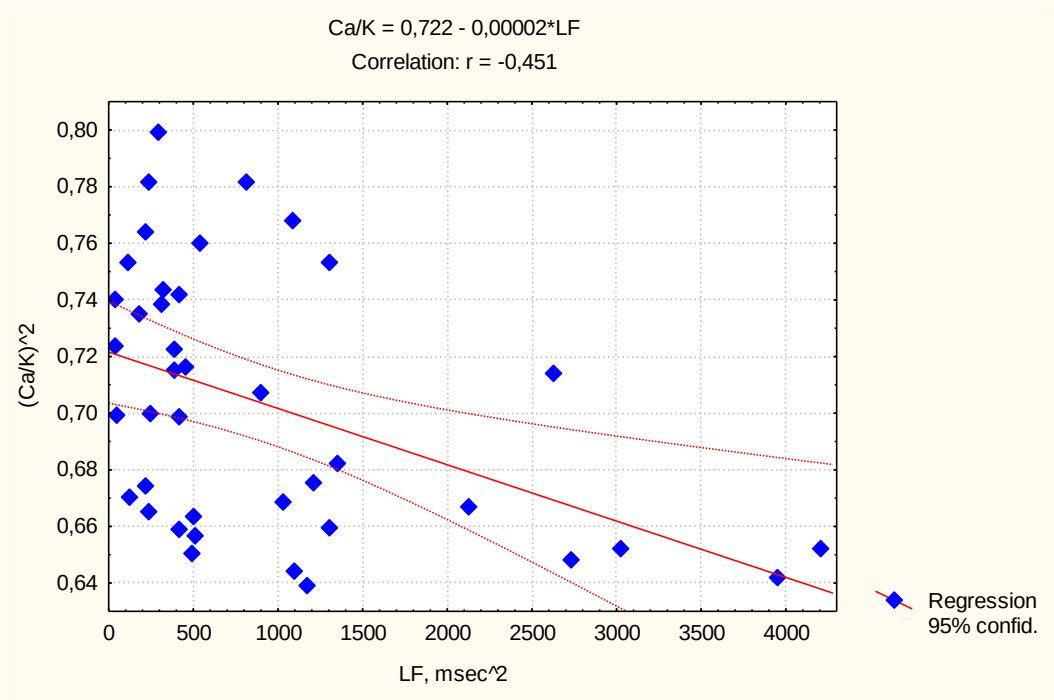

Fig. 2. Correlation between PS LF HRV (axis X) and Ca/K Plasma Ratio (axis Y)

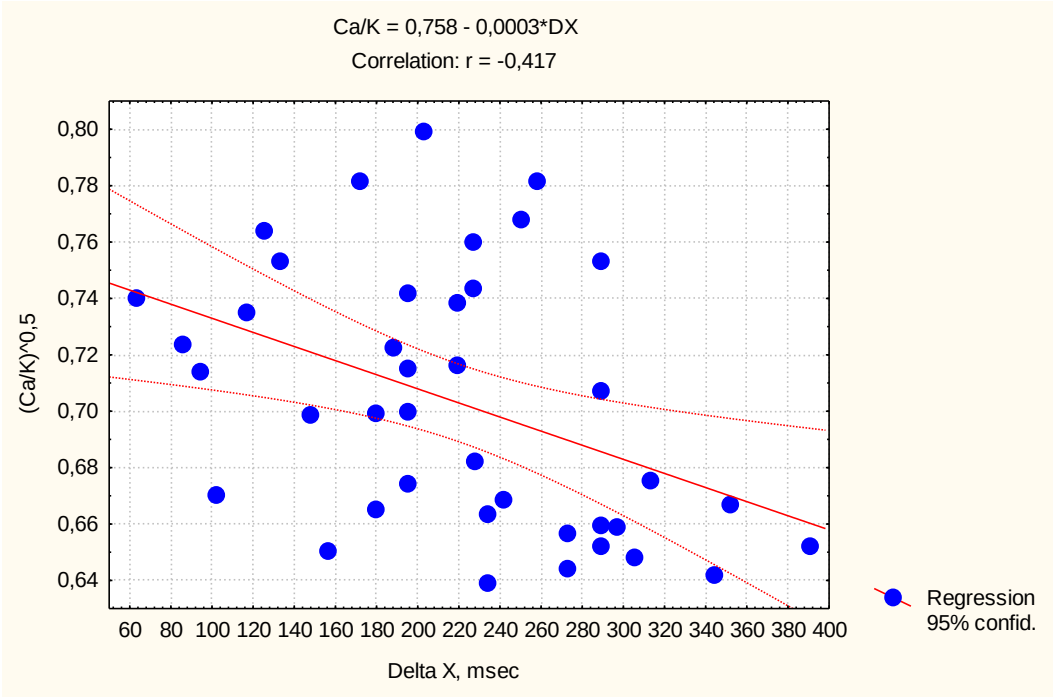

Fig. 3. Correlation between variational sweep (axis X) and Ca/K Plasma Ratio (axis Y)

For portion of age norm (DX_{an}=307,5 - 2,9644•Age) correlation is more strong (Fig. 4).

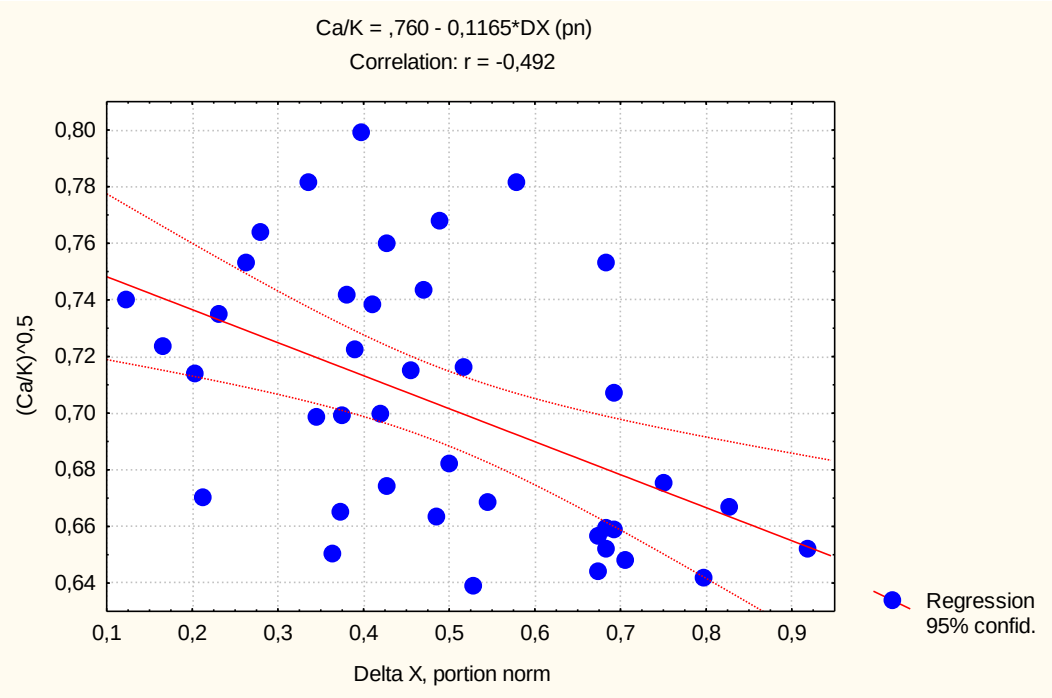

Fig. 4. Correlation between portion norm of variational sweep (axis X) and Ca/K Plasma Ratio (axis Y)

On the other hand, Ca/K Plasma Ratio correlates positively with sympathetic marker Amplitude of Moda (r=0,24 for actual values and 0,38 for portion of age norm: AMo_{an}=23,0 – 0,0114•Age^2 +0,8763•Age) (Fig. 5).

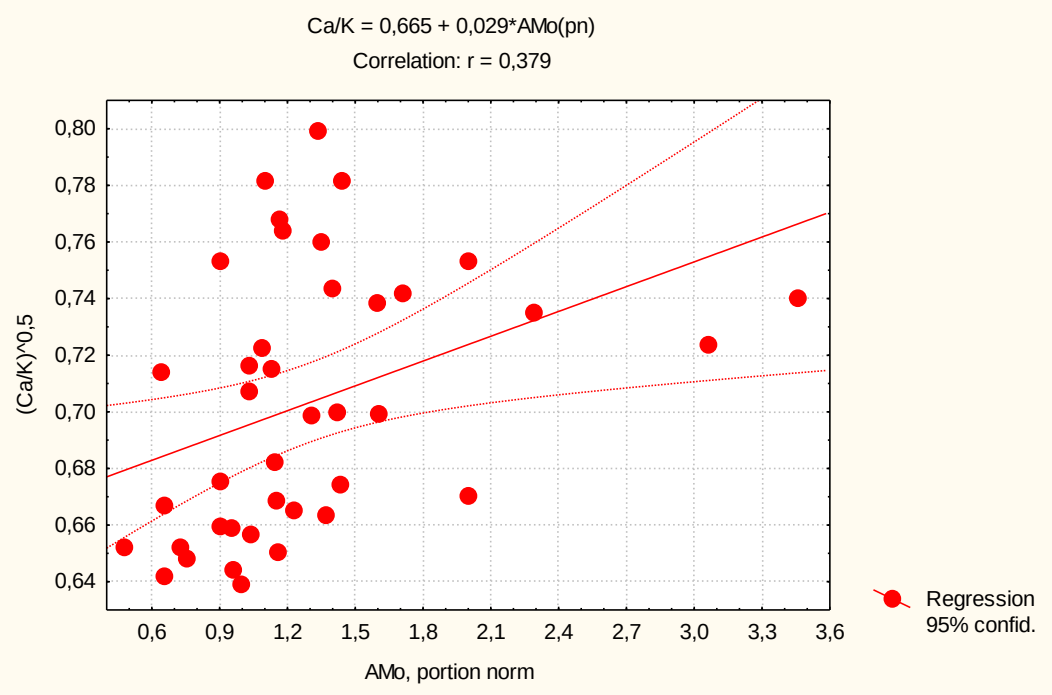

Fig. 5. Correlation between portion norm of Amplitude of Moda (axis X) and Ca/K Plasma Ratio (axis Y)

We detected also positively correlation Ca/K Plasma Ratio with relative PS ULF (r=0,39) and VLF (r=0,31).

Canonical correlation between Ca/K Plasma Ratio, on the one hand, and the parameters of HRV, on the other hand, is strong (Table 1, Fig. 6).

Table 1. Regression Summary for Dependent Variable: Ca/K-Ratio
R=0,713; R^2=0,509; Adjusted R^2=0,437; $F_{(5,3)}$=7,0; $\chi^2_{(5)}$=25,2; $p=10^{-4}$; Std. Error of estimate: 0,03

	Beta	St. Err. of Beta	B	St. Err. of B	$t_{(34)}$	p-level
Interception			0,707	0,021	34,3	10^{-6}
ΔX, portion norm	-0,507	0,252	-0,120	0,060	-2,01	,052
LF HRV absolute	-0,451	0,223	-0,00002	0,00001	-2,03	,051
ULF HRV relative	0,216	0,128	0,0021	0,0012	1,69	,101
RMSSD, port. norm	0,293	0,141	0,013	0,006	2,08	,046
HRV TI	0,387	0349	0,0043	0,0039	1,11	,275

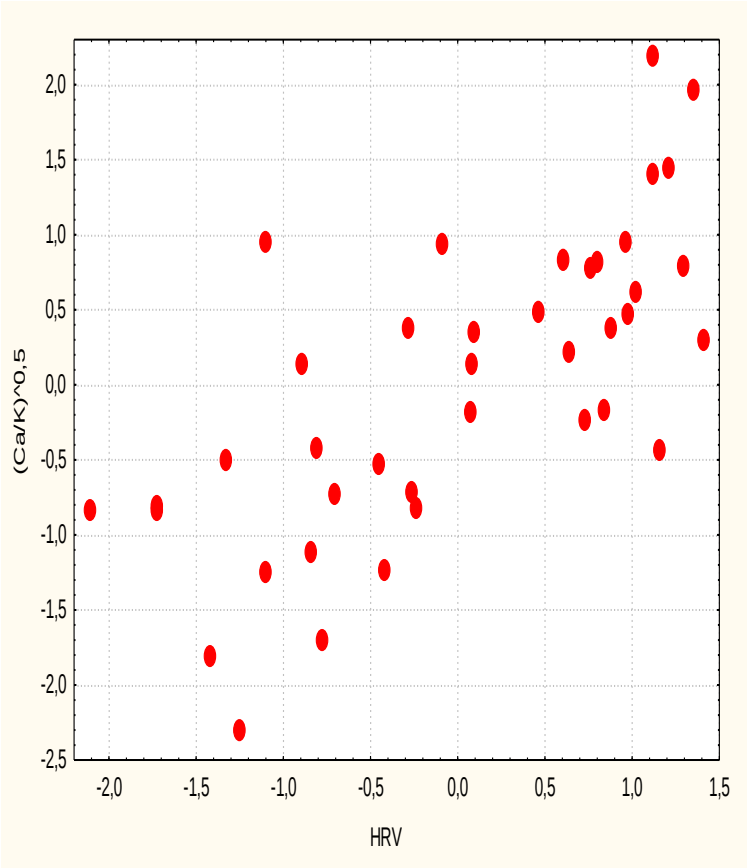

Fig. 6. The canonical correlation between the parameters of HRV (axis X) and Plasma Ca/K Ratio (axis Y)

Therefore, unlike Kerdoe's Vegetative Index, Ca/K Plasma Ratio reflects the real state of the autonomic nervous system.

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