ELECTRICAL CONDUCTIVITY OF SOME POINTS OF ACUPUNCTURE CORRELATES WITH AGE, BLOOD PRESSURE AND HEART RATE VARIABILITY

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Abstract

Background. Thoughts about the informativeness of the parameters of acupuncture points are ambiguous, therefore studies in this direction remain relevant. **Material and Methods**. The object of observation were 14 practically healthy men aged 24-60 years old. We recorded Blood Pressure ("Omron M4-I"), parameters of Heart Rate Variability ("CardioLab+HRV") and electroskin conductivity ("Medissa") in follow points of acupuncture: Pg(ND), TR(X) and MC(AVL) at Right and Left side, which represents, as it is believed, the nervous, endocrine and immune systems respectively. The survey was conducted two time with an interval of 4 days. Results processed by methods of correlation and canonical analyses, using the software package "Statistica 5.5". **Results.** The most informative among the registered parameters of the points of acupuncture are conductivity for TR(X) R&L as well as its Laterality Index for MC(AVL), which represent inversely Vagal tone and directly Sympathetic-Vagal balance, as well as Blood Pressure, to a greater extent Diastolic. **Conclusion.** Parameters of the points of acupuncture reflexes at least the state of the autonomic nervous system and associated blood pressure.

Keywords: points of acupuncture, conductivity, HRV, blood pressure, practically healthy men.

INTRODUCTION

Thoughts about the informativeness of the parameters of acupuncture points, that their relationship with the parameters of the autonomic nervous, endocrine and immune systems, are ambiguous [3,4,6-9], therefore studies in this direction remain relevant.

MATERIAL AND RESEARCH METHODS

The object of observation were 14 practically healthy men aged 24-60 years old. The survey was conducted two time with an interval of 4 days.

We recorded firstly during 7 min electrocardiogram in II lead to assess the parameters of heart rate variability (HRV) [1,2,5] (hardware-software complex "CardioLab+HRV" production "KhAI-Medica", Kharkiv, Ukraine). For further analysis the following parameters HRV were selected. Temporal parameters (Time Domain Methods): the standart deviation of all NN intervals (SDNN), coefficient of variation (Cv), 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 (HRV TI); heart rate (HR), moda (Mo), the amplitude of moda (AMo), variational sweep (MxDMn). Spectral parameters (Frequency Domain Methods): spectral power density (SPD) bands 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). We calculated also classical indexes: LF/HF, LFnu=100%•LF/(LF+HF), Baevskiy's Index of Sympatho-Vagal Balance (AMo/MxDMn).

Then Blood Pressure ("Omron M4-I", Netherlands) as well as electroskin conductivity ("Medissa") recorded in follow points of acupuncture: Pg(ND), TR(X) and MC(AVL) at Right and Left side, which represents, as it is believed, the nervous, endocrine and immune systems respectively [6,9]. For each pair of points, Laterality Index (LI) was calculated according to the formula:

LI = 200%•(R-L)/(R+L).

Results processed by methods of correlation and canonical analyses, using the software package "Statistica 5.5".

RESULTS AND DISCUSSION

According to the formula:
$$|r| \geq \{exp[2t/(n-1,5)^{0,5}] - 1\}/\{exp[2t/(n-1,5)^{0,5}] + 1\},$$
for a sample of 28 observations critical value of correlation coefficient module at p<**0,05** (t>2,06) is 0,38, at p<**0,01** (t>2,78) is 0,49, at p<**0,001** (t>3,71) is 0,62.

As can be seen from Table 1, the pairwise relationships between the points of acupuncture (PA) of the same name on the right and left side are strong and very strong; instead, the different points are correlated moderately or even weakly, that is, it probably reflects different processes.

Table 1. Matrix correlations between the electrical conductivity of points of acupuncture

Acupuncture points	Pg(ND) R	Pg(ND) L	Pg(ND) LI	MC(AVL) R	MC(AVL) L	MC(AVL) LI	TR(X) R	TR(X) L
Pg(ND) R	1,00							
Pg(ND) L	**,95**	1,00						
Pg(ND) LI	,30	-,00	1,00					
MC(AVL) R	**,40**	**,42**	*-,01*	1,00				
MC(AVL) L	**,49**	**,53**	*-,06*	**,95**	1,00			
MC(AVL)LI	-,37	**-,43**	*,12*	-,10	**-,41**	1,00		
TR(X) R	**,59**	**,57**	*,15*	,33	,36	*-,15*	1,00	
TR(X) L	**,59**	**,65**	-,10	**,45**	**,50**	-,20	**,87**	1,00
TR(X) LI	*-,21*	-,37	**,48**	-,37	**-,40**	*,10*	*-,12*	**-,58**

Nevertheless, in regressive models with step-by-step exclusion, there were separate variables with the values |r| less than critical level.

In particular, the conductivity of PA Pg (ND) R significantly correlates negatively with age, that is, it reflects, apparently, the processes caused by aging. In addition, it reflects inversely sympathetic-vagal balance (Table 2).

Table 2. Regression Summary for Dependent Variable: Pg(ND) R
R=0,527; R^2=0,278; Adjusted R^2=0,187; $F_{(3,2)}$=3,08; p=0,047; SE: 4,7 un.

		Beta	St. Err. of Beta	B	St. Err. of B	n=28 $t_{(24)}$	p-level
Variables	r		Intercpt	52,5	8,9	5,87	10^{-5}
Age, years	**-0,39**	-,298	,208	-,129	,090	-1,43	,166
AMo/MxDMn, un.	-0,32	-,263	,218	-,007	,006	-1,21	,239
LFnu, %	0,23	,348	,183	,192	,101	1,90	,070

Instead, the contralateral point reflects the age and level of systolic blood pressure (Table 3).

Table 3. Regression Summary for Dependent Variable: Pg(ND) L
R=0,617; R^2=0,381; Adjusted R^2=0,303; $F_{(3,2)}$=4,9; p=0,008; SE: 4,3

		Beta	St. Err. of Beta	B	St. Err. of B	n=28 $t_{(24)}$	p-level
Variables	r		Intercpt	47,6	10,1	4,70	10^{-4}
Age, years	**-0,49**	-,581	,166	-,246	,070	-3,51	,002
BP Systolic, mmHg	0,23	,242	,165	,097	,066	1,46	,157
LFnu, %	0,21	,269	,163	,145	,088	1,65	,112

To a greater extent connected with systolic blood pressure Laterality Index for this pair (Table 4).

Table 4. Regression Summary for Dependent Variable: Pg(ND) LI
R=0,436; R^2=0,190; Adjusted R^2=0,126; $F_{(2,3)}$=2,9; p=0,071; SE: 2,5 %

		Beta	St. Err. of Beta	B	St. Err. of B	n=28 $t_{(24)}$	p-level
Variables	r		Intercpt	6,83	4,68	1,46	,157
BP Systolic, mmHg	-0,33	-,371	,184	-,077	,038	-2,01	,055
Age, years	0,26	,324	,184	,072	,041	1,76	,091

Canonical correlation between parameters of points of acupuncture Pg(ND) and other parameters is strong (Fig. 1 and Table 5).
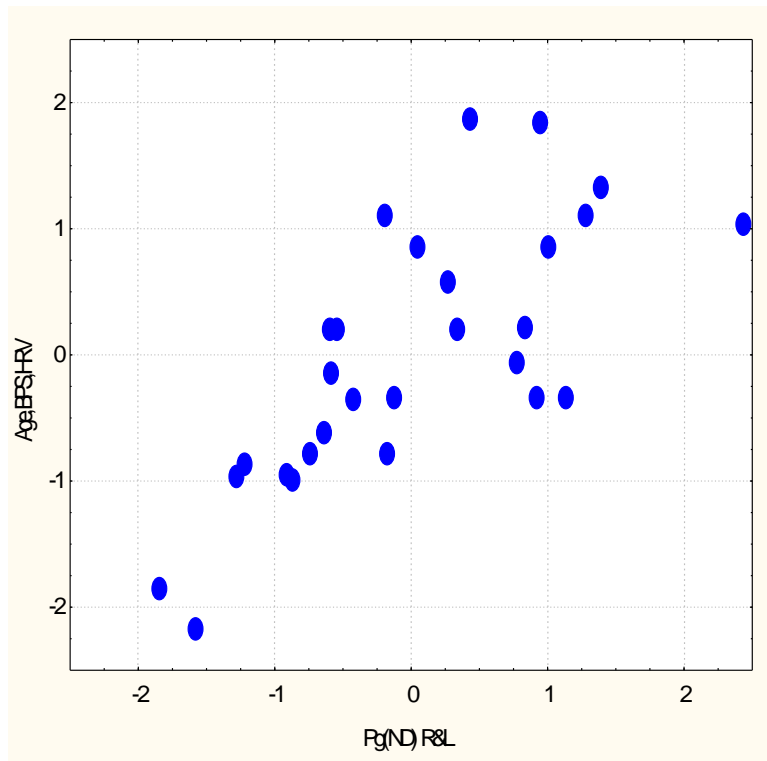
R=0,741; R^2=0,549; $\chi^2_{(12)}$=24; p=0,019; Λ Prime=0,349

Fig. 1. Canonical correlation between parameters of points of acupuncture Pg(ND) (X) and other parameters (Y)

Table 5. Factor Structure of the first pair of canonical roots

Right set	Root 1
Pg(ND) L	**-,796**
Pg(ND) R	**-,599**
Pg(ND) LI	**,533**
Left set	Root 1
Age	**,713**
AMo/MxDMn	,166
BP Systolic	**-,412**
LFnu	**-,335**

The conductivity of PA MC(AVL) R significantly correlates negatively with age also, while positively with Heart Rate, Systolic Blood Pressure as well as other index of sympathetic-vagal balance (Table 6).

Table 6. Regression Summary for Dependent Variable: MC(AVL) R
R=0,620; R^2=0,385; Adjusted R^2=0,278; $F_{(4,2)}$=3,6; p=0,020; SE: 4,6 un.

		Beta	St. Err. of Beta	B	St. Err. of B	n=28 $t_{(24)}$	p-level
Variables	r		Intercpt	50,9	10,3	4,94	10^{-4}
Age, years	**-0,40**	-,502	,172	-,224	,077	-2,92	,008
Heart Rate, beats/min	0,33	,221	,180	,095	,077	1,23	,231
BP Systolic, mmHg	0,28	,244	,168	,103	,071	1,45	,161
LF/HF	0,22	,235	,181	,161	,124	1,30	,207

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The contralateral point reflects both the same parameters, and others (Table 7).

Table 7. Regression Summary for Dependent Variable: MC(AVL) L
R=0,647; R^2=0,418; Adjusted R^2=0,286; $F_{(5,2)}$=3,2; p=0,027; SE:4,9 un.

		Beta	St. Err. of Beta	B	St. Err. of B	n=28 $t_{(24)}$	p-level
Variables	r		Intercpt	19,9	24,0	,83	,415
Age, years	**-0,49**	-,323	,276	-,155	,132	-1,17	,255
100•VLF/TP, %	-0,27	,356	,262	,138	,102	1,36	,188
C_V, %	0,30	,448	,330	1,084	,800	1,35	,189
Heart Rate, beats/min	0,25	,466	,269	,215	,124	1,73	,097
LFnu, %	0,23	,404	,196	,246	,119	2,07	,051

The most numerous and strongest connections have been found with respect to the Laterality Index for PA MC(AVL). First of all, it's a vagal marker Variative Swing (Fig. 2) as well as another markers: RMSSD, spectral power of HF band HRV and total power of HRV. Contradictory correlates with Laterality Index Diastolic Blood Pressure (Table 8).

Canonical correlation between parameters of points of acupuncture MC(AVL) and other parameters turned out to be stronger than the previous pair (Fig. 3 and Table 9).
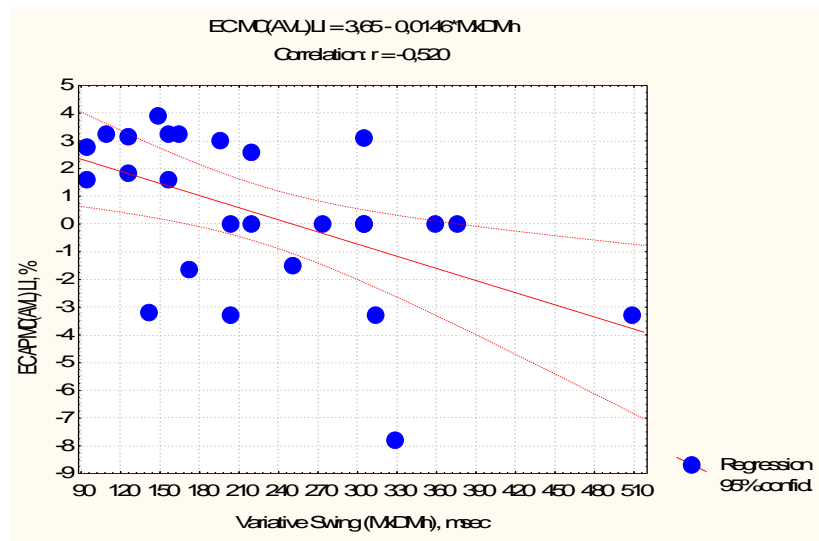

Fig. 2. Correlation between Variative Swing HRV (X) and Laterality Index for electrical conductivity of points of acupuncture MC(AVL) (Y)

Table 8. Regression Summary for Dependent Variable: MC(AVL) LI
R=0,671; R^2=0,450; Adjusted R^2=0,325; $F_{(5,2)}$=3,6; p=0,016; SE: 2,3 %

		Beta	St. Err. of Beta	B	St. Err.of B	$t_{(24)}$	p-level
Variables	r		Intercpt	-5,82	5,39	-1,08	,292
BP Diastolic, mmHg	**0,45**	,467	,194	,1374	,0570	2,41	,025
MxDMn, ms	**-0,52**	-1,896	,723	-,0549	,0209	-2,62	,016
TP, ms^2	**-0,44**	1,567	,914	,0016	,0010	1,71	,100
RMSSD, ms	-0,37	1,060	,504	,1896	,0902	2,10	,047
HF, ms^2	-0,34	-1,004	,549	-,0062	,0034	-1,83	,081
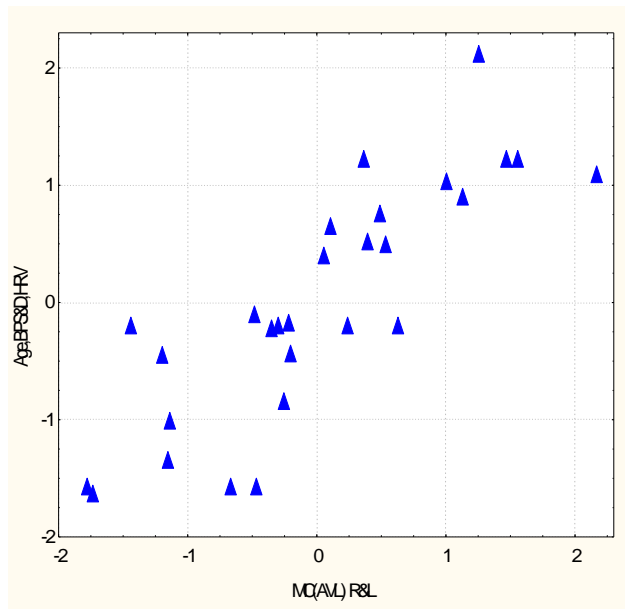
R=0,838; R^2=0,702; $\chi^2_{(33)}$=47; p=0,052; Λ Prime=0,089

Fig. 3. Canonical correlation between parameters of points of acupuncture MC(AVL) (X) and other parameters (Y)

Table 9. Factor Structure of the second pair of canonical roots

Right set	Root 1
MC(AVL) LI	**,865**
MC(AVL) R	,059
MC(AVL) L	**-,208**
Left set	Root 1
BP Diastolic	**,633**
Heart Rate	**,283**
Age	,173
BP Systolic	,052
MxDMn	**-,530**
C_V	**-,502**
TP	**-,499**
RMSSD	**-,399**
HF	**-,383**
LF/HF	**-,291**
LFnu	-,150

The conductivity of PA TR(X) R, unlike the previous points, significantly correlates negatively with vagal markers (Table 10).

Table 10. Regression Summary for Dependent Variable: TR(X) R
R=0,684; R^2=0,467; Adjusted R^2=0,375; $F_{(4,2)}$=5,0; p=0,005; SE: 3,5 un.

		Beta	St. Err. of Beta	B	St. Err. of B	n=28 $t_{(24)}$	p-level
Variables	r		Intercpt	74,2	3,29	22,5	10^{-6}
100•HF/TP, %	**-0,41**	-,284	,199	-,2335	,1635	-1,43	,167
pNN_{50}, %	**-0,39**	-1,088	,451	-,4703	,1948	-2,41	,024

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			St. Err. of Beta	B	St. Err. of B	n=28 t(24)	p-level
HF, ms^2	-0,27	,689	,450	,0066	,0043	1,53	,139
Age, years	-0,22	-,561	,175	-,2066	,0646	-3,20	,004

To a lesser extent, this is characteristic of the contrlateral point, in spite of this, the coefficient of multiple correlation was identical (Table 11).

Table 11. Regression Summary for Dependent Variable: TR(X) L
R=0,682; R^2=0,465; Adjusted R^2=0,398; F$_{(3,2)}$=6,9; p=0,002; SE :4,3 un.

		Beta	St. Err. of Beta	B	St. Err. of B	n=28 t(24)	p-level
Variables	r		Intercpt	77,2	3,86	20,0	10^{-6}
Age, years	-0,31	-,635	,172	-,2909	,0788	-3,69	,001
pNN$_{50}$, %	-0,34	-1,211	,438	-,6509	,2356	-2,76	,011
HF, ms^2	-0,23	,622	,435	,0075	,0052	1,43	,166

Laterality Index for PA TR(X) correlates with Blood Pressure opposite MC(AVL): r=-0,44 vs 0,27 and -0,27 vs 0,45 for Systolic and Diastilic respectively. Signs opposite are also found in relation to the ULF band HRV and LFnu: r=0,23 vs -0,28 and 0,25 vs -0,11 respectively. Instead, with the age of the connection are single-sided: r=0,25 and 0,39 respectively. As a result, the multiplier correlation coefficient was lower (Table 12).

Canonical correlation between parameters of points of acupuncture TR(X) and other parameters turned out to be smaller than the previous pair and equal to the first pair (Fig. 4 and Table 13).

Table 12. Regression Summary for Dependent Variable: TR(X) LI
R=0,644; R^2=0,414; Adjusted R^2=0,313; F$_{(4,2)}$=4,1; p=0,012; SE: 3,3 %

		Beta	St. Err. of Beta	B	St. Err. of B	n=28 t(24)	p-level
Variables	r		Intercpt	1,019	8,229	,12	,902
BP Systolic, mmHg	**-0,44**	-,473	,165	-,1477	,0515	-2,87	,009
LFnu, %	0,25	,291	,164	,1226	,0689	1,78	,088
ULF, ms^2	0,23	,323	,170	,0032	,0017	1,90	,070
Age, years	0,25	,381	,170	,1261	,0563	2,24	,035
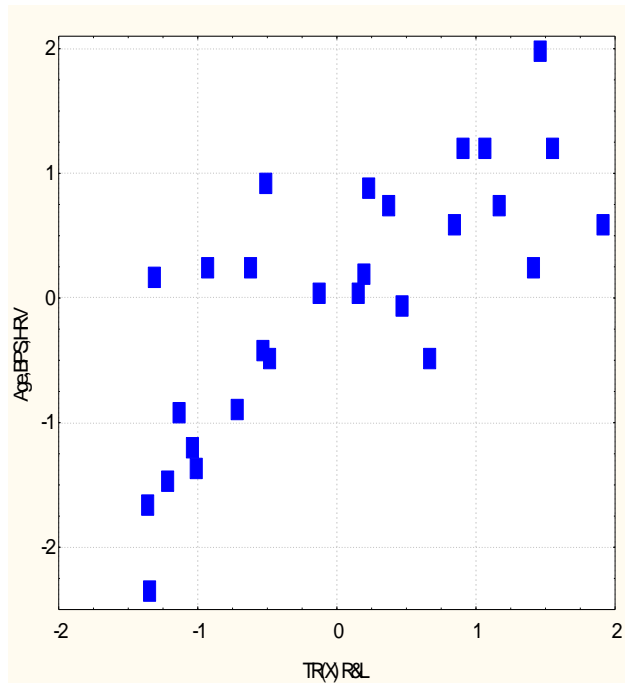
R=0,753; R^2=0,567; $\chi^2_{(21)}$=35; p=0,030; Λ Prime=0,198

Fig. 4. Canonical correlation between PA TR(X) (axis X) and other parameters (axis Y)

**Table 13. Factor Structure of the third pair of canonical roots**

Right set	Root 1
TR(X) LI	**,867**
TR(X) L	**-,642**
TR(X) R	**-,286**
Left set	Root 1
BP Systolic	**-,682**
100•HF/TP	-,103
ULF	**,337**
pNN_{50}	**,291**
Age	**,282**
HF	**,207**
LFnu	,135

On the basis of the canonical correlation analysis between all the recorded parameters of the three pairs of points of acupuncture, on the one hand, and parameters of HRV, Blood Pressure as well as age - on the other hand, the maximum factor loads was detected by PA TR(X) L&R as well as Laterality Index for PA MC(AVL) (Table 14).

Table 14. Factor Structure of the fifth pair of canonical roots

Right set	Root 1
TR(X) L	**,678**
TR(X) R	**,559**
MC(AVL) LI	**,480**
MC(AVL) R	**,372**
Pg(ND) L	**,258**
Pg(ND) R	,216
MC(AVL) L	,209
TR(X) LI	**-,442**

Pg(ND) LI	-,096
Left set	Root 1
BP Diastolic	**,499**
AMo/MxDMn	**,306**
Heart Rate	,137
BP Systolic	,116
LFnu	,079
pNN$_{50}$	**-,376**
RMSSD	**-,303**
C$_V$	**-,273**
HF	**-,264**
TP	**-,234**
MxDMn	**-,213**
Age	-,159
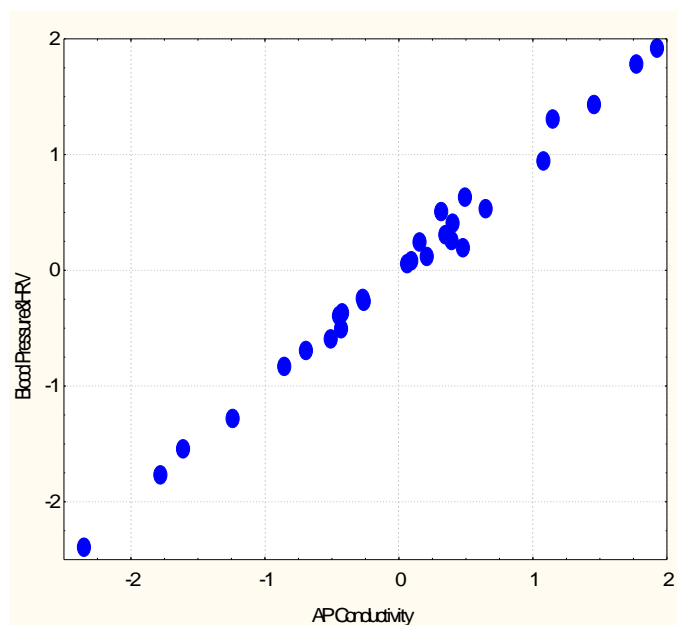
R=0,995; R^2=0,991; $\chi^2_{(144)}$=187; p=0,009; Λ Prime<10^{-5}

Fig. 5. Canonical correlation between parameters of registered points of acupuncture (axis X) and parameters of blood pressure and HRV (axis Y)

The opposite canonical root receives the maximum factor loads with the same sign from diastolic pressure and sympathetic-vagal balance while opposite sign from temporal and spectral markers of vagal tone. Interestingly, the factor load from the age turned out to be insignificant.

In general, canonical correlation between parameters of registered points of acupuncture and parameters of blood pressure and HRV turned out to be very strong (Fig. 5).

CONCLUSION

The obtained results give grounds for concluding that the most informative among the registered parameters of the points of acupuncture are conductivity for TR(X) R&L as well as its Laterality Index for MC(AVL), which represent inversely vagal tone and directly sympathetic-vagal balance, as well as arterial blood pressure, to a greater extent diastolic.

ACCORDANCE TO ETHICS STANDARDS

Tests in patients are conducted in accordance with positions of Helsinki Declaration 1975, revised and complemented in 2002, and directive of National Committee on ethics of scientific researches. During realization of tests from all participants the informed consent is got and used all measures for providing of anonymity of participants.

For all authors any conflict of interests is absent.

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