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The Difference in Complex Psychomotor Reaction Time Between Patients With and Without Signs of Cerebral Circulatory Disorders

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A B S T R A C T

On a sample of 65 subjects rheoencephalography (REG) – the electrical impedance plethysmographic method for assessment of cerebral circulation was applied, as well as an electronic psychodiagnostic instrument Complex Reactionmeter Drenovac (CRD) constructed for assessment of complex psychomotor reactions. The aim of this study was to evaluate the potential differences between subjects with and without signs of cerebral circulatory disorders with regard to speed, stability and accuracy of complex psychomotor reaction. The results revealed that variable »maximal speed« on CRD showed significant difference between the groups, in favor of the control group.

Introduction

The study of the influence of cerebral circulation on complex psychomotor reactions has attracted relatively few workers, possibly because the practical benefits are small in proportion to the investment in time, effort and resources required. Nevertheless, the speed and accuracy of psychomotor reactions remain one of the factors that experimental psychology can rely on as measurable variables. The impact of functional physiological variables of central nervous system on psychological performance will, thus, stay in the focus of scientific interest.

This investigation was based on the assumption that signs of cerebral circulatory disorders (CCD) on the basis of REG finding, regardless of its cause, could influence speed and accuracy of complex psychomotor performance. The actual performance was assessed using Complex Reactionmeter Drenovac (CRD) – electronic psychodiagnostic test battery, which has already proven itself as a sensitive diagnostic instrument on different diagnostic groups[1–5].

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Rheoencephalography (REG) is a non-invasive and non-disturbing electrical impedance plethysmographic method for continuous cerebral blood flow monitoring, which enables insight into the cerebral blood circulation efficiency. It is based on the measurement of the head tissue ohmic resistance during electric current flow[6]. Blood, as a good electric current conductor reduces this resistance in the systolic phase, while during the diastolic phase the resistance increases. These periodic electric resistance oscillations influenced by systoles and diastoles create the REG curve, which enables calculations on the tonus and elasticity of the blood vessels and consequently assessment of the blood supply to the brain in certain arterial flows. Thus several investigators suggested that REG could be successfully used to assess the functional status of cerebral blood circulation[7–11], and conclude on the possible presence of atherosclerotic changes on cerebral blood vessels[12]. Roemer[13] suggested that the REG may reflect regional cerebral effects associated with cognition and psychopathology. Jevning et al.[14] published a paper on effects of transcendental meditation on regional cerebral blood flow using REG method. Troshian and Vasin[15] suggested REG method together with electrocardiography and specially prepared questionnaire for preventive mass screening usage.

Different psychological and physiological techniques that are not time consuming and are easily reproducible may help in understanding the complex multifactorial connection between physiological and psychometric variables.

Subjects and Methods

Subjects

Our sample comprised 65 right-handed subjects of both sexes, aged from 30 to 59 years, with education 6 to 12 years, which would denote the whole sample as middle aged. They were all randomly chosen patients submitted to our Institute during the six months period for assessment of their health status, and were suffering from different chronic diseases: musculo-skeletal, gastro-intestinal, high blood pressure, neurosis and some professional diseases. Patients suffering from psychosis or central nervous system diseases were not submitted to the study. On the basis of REG findings they were divided into two groups. The first comprised 37 patients with evident signs of altered cerebral circulation, while remained 28 had normal REG. On the basis of complete neurologic examination and other indicated diagnostic procedures the first group was defined as slightly to mildly cerebral circulatory disorder (CCD) group, without other neurologic consequences. Neither of CCD patients had previous diagnosis of brain stroke, transitory ischemic attacks or clinically evident signs of cerebral circulation problems, nor were observed REG changes severe.

CCD group comprised 37 subjects with the prevalence of the first diagnosis as follows: Musculo-skeletal disease (Sy LS, Sy L, Sy S, Lumboischialgia): 14; Gastro-intestinal disease (Ulcus ventriculi/duodeni): 4; Neurosis: 8; Hypertension: 7; Occupational disease (Allergy, Dermatitis): 4. The prevalence in the group of 28 subjects without CCD were: Musculo-skeletal disease: 12; Gastro-intestinal disease: 1; Neurosis: 7; Hypertension: 4 and Occupational disease: 4.

Due to the significant age range all subjects were divided into two age subcategories: younger: 30 to 49 years (N= 26); and older: 50 to 59 years (N=39).

REG

As a research procedure, REG has been used since the 60 – 70s as a tool for diagnosis of cerebrovascular disorders because of its simplicity of use and well-devel-

oped procedures for REG waveform recognition. As a rule, physicians in clinics make quantitative and qualitative estimations of the REG waveform for defining of cerebral vascular changes, particularly arteriosclerotic syndrome differentiation from various types of vessel tonus raising[16].

The recording was carried out on a »Rheoencephalograph« using the application of bi-polar technique. The criteria for determining reduced elasticity and increased cerebral blood vessels tonus and consequently the potential functional damage to the cerebral circulation was the distortion degree of the anacrote part of the tracing and the position of incisura and dicrotic spike[17–19].

On the basis of such REG analysis subjects were divided into two groups:

1. Without signs of damaged cerebral circulation (anacrote part of the curve with sharp peak or distorted from its upper third part), incisura and dicrotic spike in the upper third part of the dicrotic spike.

2. With signs of DCC (anacrotic part of the curve distorted from the halfway or lower, incisura and dicrotic spike close to the peak of the dicrotic wave).

Rheoencephalography was performed using RIZ-Zagreb laboratory equipment for REG and EEG analysis and recording. Subjects were seated in a comfortable chair with adjustable back, head and arm supports. To measure REG, silver chloride electrodes of 20 mm were placed in the bi-frontal and bi-occipital positions of the head.

CRD

Complex Reactionmeter Drenovac is an electronic psychodiagnostic test series. The CRD 41 test measures complex psychomotor reactions to visual stimuli. The whole test consists of 35 tasks of varying difficulty, requiring a single limb reaction or a combination of simultaneous reactions with arms and/or legs. Four red signal lamps are situated in a signal board, where upper lamps require right and/or left hand reactions while the lower require right and/or left leg pressure on the pedals. The signal board contains unambiguously defined instruction: the lighted signal lamp/ lamps determine which extremity/extremities and in what combination are to be used. Fifteen possible reaction combinations are possible: four with one limb, six with two, four with three and one with all four limbs. Only correct reaction leads to the next task, without any delay. Four variables were used for statistical analysis:

TT = Total time needed for the whole test.

MS = Maximum speed on any of the tasks except the first one. All MS reactions were expectedly obtained on the task that requires reaction with right hand only.

TB = Total ballast, i.e. the loss of time through the test. TB is calculated by adding up the differences between maximal speed and all other reaction times through the test. TB = TT – (tx – MS); where tx represents single task reaction time.

TE = Total number of errors on all 35 tasks.

Raw results for variables TT an MS are presented in tenths of seconds. The whole test procedure with instructions lasts for only five to seven minutes.

Statistic analysis included analysis of variance (F), Kruskal-Wallis test (one-way analysis of variance of the ranged results). Ranged results are preferred in speed tests because they give a more exact picture than raw scores, eliminating extremes.

Results and Discussion

The differences found in CRD 41 test results between patient with and without cerebral circulatory disorders (CCD) are

shown in Table 1. Small number of subjects and consequently relatively great variability of the results was partly neutralized by Kruskal-Wallis ranged data analysis of variance.

Statistically significant difference was found for the variable maximal speed (MS) only, at the level of p = 0.016. It is also evident that other three observed variables: total time (TT), total ballast (TB) and total number of errors (TE), distinctly show tendency toward the better results in healthy subjects. We could therefore, speculate on the probable statistical significance in these parameters as well, in a bigger sample.

Respecting a fact that the majority of our younger subjects are without CCD, while the majority of older subjects show signs of CCD, further statistical analysis was done on four subject subcategories according to age and cerebral blood circulation status:

1. Younger (<49 years) without CCD (N=18); 2. Younger with CCD (N=8); 3. Older (>50 years) without CCD (N=10); and 4. Older with CCD (N=29). Detailed age values are presented in Table 2. Again, the only statistically significant difference (p = 0.025) was found for variable maximal speed on any of the CRD tasks (MS), i.e. subjects with CCD performed significantly slower in both age subgroups (Table 2).

Interestingly enough the difference that we found, is greater in younger than in older subjects. This fact has even more significance and potential pragmatic value than the difference found in older subjects where there are usually much more signs of changed CNS functional status at the level of subjective symp-

TABLE 1
CRD 41 TEST RESULTS IN PATIENTS WITHOUT AND WITH CEREBRAL CIRCULATORY DISORDERS (CCD). TT, MS AND TB IN HUNDRETHS OF A SECOND

Variable	Without CCD	With CCD	F-test	p	KW test	p
N	28	37	–	–	–	–
TT	1004.2	1497.8	3.0068	0.0876	2.4853	0.1149
MS	10.7	13.6	3.8247	0.0549	5.7278	0.0166*
TB	612.5	728.4	1.4272	0.2367	1.2532	0.2629
TE	13.2	15.3	1.1547	0.2866	0.7816	0.3766

* p<0.05

TABLE 2
CRD 41 TEST RESULTS FOR FOUR AGE-DIAGNOSE CATEGORIES (N=65). TT, MS AND TB IN HUNDRETHS OF A SECOND

Variable	Younger		Older		F-test	p	KW test	p
	Without CCD	With CCD	Without CCD	With CCD				
N	18	8	10	29	–	–	–	–
Age	40.1	37.4	53.0	53.8	–	–	–	–
TT	847.2	1295.5	1286.9	1553.6	1.414	0.247	6.545	0.088
MS	9.6	13.6	12.8	13.6	1.935	0.133	9.375	0.025*
TB	505.8	735.1	804.6	726.5	1.807	0.155	5.813	0.121
TE	11.2	15.2	16.8	15.3	1.471	0.231	4.849	0.348

* p<0.05

toms. It must be stressed that the prolongation of reaction time itself is not monosymptomatic, and can function in practice only as a variable in the complete psychodiagnostic procedure. Knowing that cardiovascular diseases are the most common cause of hospitalization in the aged[20], early detection of cerebral circulatory disorders gain on the importance.

Conclusions

1. This study showed that Complex Reactionmeter Drenovac (CRD) is a sensitive method of assessing the effects of slightly to moderately altered cerebral circulation measured by rheoencephalographic technique with regard to speed and accuracy of complex psychomotor reactions.

2. Although both age subgroups show decreased speed and accuracy and increased ballast in the complex psychomotor reaction, the only statistically significant difference between those with signs of cerebral circulatory disorders and those without such signs was found in the variable »maximal speed« that was achieved on CRD 41 test.

Having in mind the fact that in younger subjects we found the same significant difference, we may conclude that estimation of reaction times to complex visual stimuli may be very useful as a part of screening method for assessment of health status especially in younger subjects.

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RAZLIKA U VREMENU SLOŽENE PSIHOMOTORNE REAKCIJE U OSOBA SA I BEZ ZNAKOVA POREMEĆAJA CEREBRALNE CIRKULACIJE

S A Ž E T A K

U uzorku od 65 osoba izvršeno je ispitivanje cerebralne cirkulacije određivanjem električne impedancije pletizmografskom metodom – reoencefalografijom (REG), te složene psihomotorne reakcije elektroničkim psihodijagnostičkim instrumentom CRD (Kompleksni Reakciometar Drenovac). Svrha rada je pronaći moguće razlike u brzini, stabilnosti i točnosti kompleksne psihomotorne reakcije u osoba s cerebralnim cirkulacijskim poremećajima i osoba bez tih poremećaja. Dobiveni podaci pokazuju da usporedna skupina u odnosu na skupinu sa znakovima poremećaja cerebralne cirkulacije postiže značajno bolje rezultate na CRD varijabli »maksimalna brzina«.