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M.B. PECYNA

THE LEVEL OF INTELLIGENCE AND HEART RATE VARIABILITY IN MEN AFTER MYOCARDIAL INFARCTION

Department of Clinical Psychology and Psychophysiology, Institute of Psychology, Opole University, Opole, Poland

Heart rate variability (HRV) reflects periodic changes taking place in heart rhythm, which are controlled by the autonomic nervous system (ANS) and external factors. The aim of the present study was to assess the relationship between HRV and the level of intelligence using the Raven Advanced Matrices Test in 95 men (mean age 41.6 ±3.7SD yr) who experienced myocardial infarction during two years preceding the psychophysiological examination. HRV was analyzed from the EEG signal recordings in the time and spectral domains. It was found that post-myocardial infarct men of the higher than average intelligence had significantly increased HRV; the finding was reflected in the analysis of both time and frequency domains. Although both sympathetic and parasympathetic components showed an increase in the frequency domain, the former did disproportionately more, achieving substantial predominance. The results indicate that active mental processes and attitude, linked to a higher intelligence level, might be a beneficial prognostic marker, as is higher HRV, for the overall post-infarction cardiac mortality and for return of such subjects back to normal life. The corollary is that the assessment of IQ in post-infarction patients seems a simple screening method that may help presage the health and social course the patient takes.

Key words: *autonomic nervous system, heart rate variability, intelligence quotient, myocardial infract*

INTRODUCTION

Heart rhythm, which is not under volitional control, is under constant modulation by both sympathetic and parasympathetic components of the autonomic neural system (1, 2). Neural modulation is essential for R-R interval variations. On the other hand, these variations may be used to assess the functional status of the autonomic system or to predict the occurrence of cardiovascular morbidity (3, 4). Post-myocardial infarction (PMI) subjects usually show signs of autonomic function imbalance consisting of a reduction in R-R intervals and in HRV, which presently are best unraveled with the use of a spectral analysis of the ECG signal (5). Decreased HRV is considered an independent risk factor for the occurrence of coronary heart diseased and sudden death even in healthy people let alone the PMI subjects.

A rarely recognized factor that seems to bear on the interindividual differences in physiological processes is the level of intelligence. Intelligence not only is subject to the principle of variability, i.e., varies from subject to subject, but also displays intraindividual changes, since in essence it relays on one's capability of adjusting his mind to ever-changing situations. Moreover, intelligence also depends on the time the mind needs to adjust to a given situation. From the epidemiological standpoint, 3% of the general population has a high IQ =120, the IQ taken as that 11% above the average 90-110 level.

In accordance with the contemporary psychophysiological knowledge (6), a disorder of the cardiovascular regulation, due to the autonomic disturbance, plays a significant role in the pathogenesis of anxiety and fear, the conditions that may underlie sudden cardiac death. Thus, the possibility of a link between the psychological status and HRV emerges. Indeed, Hajek et al (7) evaluated HRV changes during mental stress induced by a cardiology examination in fifth grade medical students and found a disproportional decrease in parasympathetic tension in relation to the increase in sympathetic tension. To get further insight into the psychological determinants and modifiers of HVR, in this study I set out to examine the relationship between the level of IQ and the activity of the autonomic system, as represented by HRV, in PMI men. The PMI subjects were chosen on the premise that they would likely be more vulnerable to psychophysiological alterations and thus the results obtained more distinct.

MATERIAL AND METHODS

The study was performed on 95 male subjects of the mean age 41.6 ±3.7SD yr, range (37-45 yr), who experienced myocardial infarct during the last two years before the psychophysiological examination. All subjects showed signs of an unstable psychic construction resulting from enhanced tension due to the anxiety and fear of uncertainty of tomorrow. This state was confirmed by electroencephalographic recordings showing low frequencies and amplitudes of alpha and high of theta waves.

All men were examined with a standard version of the Raven Advanced Matrices Test that assesses the IQ level. They were divided into 2 groups representing average and high IQ levels: Group A – (IQ=92-110; *n*=32) and Group B – (IQ=122-138; *n*=43). The rationale for this kind of stratification stemmed from our previous observations that IQ may change in proportion to the magnitude of anxiety and fear (unpublished observation).

HRV was recorded with a noninvasive feed-back technique at rest in the supine position with a ProComp+/BioGraph V2.1 integrator of the Thought Technology. Each subject was examined 5 times during a day between the following hours: 8-9, 10-11, 12-13, 14-15, and 17-18. The total time of each subject's recordings amounted to 5760 s. HRV was evaluated with two different methods built into the integrator: electrocardiographic and photoplethismographic from a fingertip, ie, in both time and spectral domains. No significant differences were noted in the parameters of either the time or frequency domain among the five measurements taken at the foregoing parts of day. Therefore, the first morning recordings performed at the 8-9 hours will be presented and discussed below. The following parameters were of interest:

- mNN - the mean of NN (normal – normal) intervals between consecutive R-R waves of the sinus rhythm;
- SDNN - standard deviation of NN intervals measured;
- SDNN INDEX - the mean of the standard deviations of one-minute measurements of NN intervals. The parameter describes a total HRV and allows the evaluation of quickly changing components;
- SDANN - standard deviation of the means of one-minute measurements of NN intervals. The parameter allows the evaluation of slowly changing HRV components;
- rMSSD - square root of the mean of squares of differences between subsequent R-R intervals examined. The parameter has to do with a short-term variability and correlates with the high frequency component in the spectral analysis. All the foregoing parameters were measured in ms.
- pNN50% - percentage of R-R intervals different from the adjacent ones ≥50 ms.

Fast Fourier Transformation (FFT) was applied to the spectral analysis of HRV. The following frequency components were differentiated:

- ULF (ultra low frequency) – 0.0000 to 0.0034 Hz;
- VLF (very low frequency) – 0.0035 to 0.0400 Hz;
- LF (low frequency) – 0.04 to 0.15 Hz, reflecting mostly sympathetic modulation;
- HF (high frequency) – 0.15 to 0.50 Hz, reflecting parasympathetic modulation.

The spectral components were expressed in ms^2 (the spectrum power units). Additionally, the total spectral power (TP), covering the 0.0 – 0.5 Hz range, and the LF/HF ratio were calculated. A CardioStat statistical package was used to evaluate HRV changes. Differences between the corresponding parameters in the two IQ-groups were assessed with a two-tailed unpaired *t* test. A P value of <0.05 was taken as indicative of statistically significant differences.

RESULTS

The HRV indicators recorded and calculated in the time domain in the group of PMI men are displayed in *Table 1*. Overall, it is clear that HRV was significantly greater in men who were of the higher intelligence level. Of all the indicators, mNN (the mean of all R-R intervals) showed the most significant difference compared with the group of men of the average intelligence level.

This analysis allowed to evaluate the dynamic balance of the autonomic nervous system, *ipso facto* it allowed a quantitative estimation of the state of tension of the sympathetic and parasympathetic components under the pressure of fear experienced by PMI subjects with connection to the possibility of having further cardiac episodes or sudden death in the near future. Further analytic procedures consisted of displaying the wave describing HRV as an aggregate of finite number of harmonic waves of various frequencies presented as the spectral power. The spectral data are displayed in *Table 2*.

Table 1. Values of the HRV indicators in the time domain recorded in post-myocardial infarction men of average (Group A) and high (Group B) intelligence levels at the 8-9 hours.

HRV indicator	Group A	Group B	P
mNN	632.2 ±24.7	892.4 ±25.6	0.001
SDNN	104.2 ±32.5	129.3 ±23.3	0.01
SDNN index	64.4 ±21.6	96.7 ±22.8	0.01
SDANN	101.1 ±36.5	138.3 ±34.6	0.05
rMSSD	43.8 ±4.9	61.1 ±3.7	0.05
pNN50	14.3 ±6.3	26.9 ±2.3	0.05

Data are means ±SD. pNN50 is in %, all the others are in ms.

Table 2. Values of the HRV indicators in the frequency domain recorded in post-myocardial infarction men of average (Group A) and high (Group B) intelligence levels at the 8-9 hours.

Spectrum Power	Group A	Group B	P
ULF	21345 ±10875	24656 ±11965	0.001
VLF	16721 ±70381	19438 ±94650	0.01
LF	1493 ±694	1690 ±934	0.05
HF	371 ±723	587 ±379	0.01
TP	7745 ±4520	7942 ±5129	0.05
LF/HF	4.23 ±3.48	3.63 ±2.69	NS

Data are means ±SD. The spectrum power is in ms^2.

In the group of PMI subjects of the higher intelligence level, the frequencies in both low and high ranges were significantly greater than those in the subjects of the average intelligence level. The increase in spectral power tended to be shifted toward the high frequency side, which was reflected in some decrease of the low/high frequency ratio. However, the increase in the ratio failed to assume statistical significance.

DISCUSSION

This study demonstrates that post-infarction male subjects with a higher than average IQ level had higher heart rate variability than those with a lower, average IQ level. This finding was confirmed in both time and frequency domains of HRV recordings. Thus, the level of intelligence, linked to the mental status, may modify heart function, controlled, to a great extent, by the function of the autonomic nervous system.

The knowledge concerning the role intelligence plays in the formation of unstable psychic constructions with the supremacy of anxiety and fear in subjects who recently suffered from myocardial infraction is meagre. Such subjects may understandably be more concerned about their health condition and the appearance of continuing cardiac problems or even about the possibility of sudden cardiac death. It may be posited that subjects of a higher than average level of intelligence are more perplexed about the condition they found themselves in, for they are better equipped mentally and educationally and thus better able to foretell the potential sequel of the disease. The hurtful thoughts could explain a greater imbalance in the autonomic control of the heart, resulting in a greater HRV. On the other hand, a greater HRV, known to be beneficial for cardiac morbidity, might stymie the occurrence of further cardiac episodes in these subjects. The inference is that a higher than average intelligence may actually be a limiting factor in the progress of cardiac morbidity in PMI subjects.

In summary, HRV was shaped by the level of intelligence, as expressed by IQ, in post-myocardial infarction men in the way that the higher the intelligence the greater the HRV. The corollary is that intelligence might have a positive effect on the cardiac sequel in such subjects. It may be concluded that the unstable psychic construction after heart attack, due to feelings of anxiety and fear, interacts with the function of autonomic nervous system and this interaction is conditioned by the level of intelligence. The assessment of IQ combined with HRV seems a potentially useful tool for the prediction of a future clinical course in a subject with PMI, his capability to adapt to physical effort and to resume job.

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Author's address: M. B. Pecyna, Department of Clinical Psychology, Institute of Psychology, Opole University, Pl. Staszica 1, 45-052 Opole, Poland; phone 77 4545841 ext. 2271;
E-mail: sje@go2.pl