

# Assessment of Body Surface Potential Mapping in VDT-Operators

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**Abstract.** Computer is a genius invention that has made human work more efficient. In spite of undeniable benefits, everyday long-term contact with computer screens is an occupational risk, which induces various undesirable health consequences. Exposure of the VDT-operators to the harmful occupational factors may lead to functional disorders like arrhythmia. BSPM is a diagnostic method enabling global and precise sampling the heart potentials all over the thoracic surface owing to the large number of recording electrodes. Data collected from 87 ECG waveforms is graphically presented as the body surface maps of various formats. Non-dipolar distribution of QRST isointegral maps reflects a heterogeneity of the refractory periods of the ventricles, which is supposed to account for creating a substrate for malignant and life-threatening arrhythmias. This method can be a specific indicator of the increased risk of severe ventricular arrhythmias occurring prior to abnormalities detectable on the standard 12-lead ECG recordings.

**Keywords:** VDT-operators, BSPM, QRST maps, ventricular arrhythmias.

## 1 Introduction

Computer and Internet are genius inventions that attracted millions of people from all over the world and made human work more efficient. In spite of undeniable benefits, computer revolution is assumed to endanger human health. Sight exposure to electromagnetic irradiation is the most frequently mentioned negative factor. However, it is often forgotten that there is a whole gamut of negative computer-related factors, like forced slouching position in front of the computer screen and the others, which may lead to functional disorders within the cardiac conductive system resulting in cardiac symptoms like arrhythmia (Janocha et al, 2003).

Body surface potential mapping (BSPM) is a diagnostic method which enables global and precise sampling the heart potentials all over the thoracic surface owing to the large number of the recording electrodes. The results of BSPM examinations are

displayed graphically in the form of so-called “heart maps” which comprise three different types: isopotential, isointegral and isochrones maps. The first kind of map shows a distribution of the instant heart potential over the thorax, the second one depicts resultant potential fluctuations occurring within the given time intervals of the cardiac cycle (area under the ECG curve) and the third type reflects the propagation of the heart depolarization over the thoracic surfaces in time. In the present study, we used isointegral maps. BSPM is of advantage over the conventional ECG in relation to a selective assessment of the individual portions of the heart and enables a detection of local electrical events unavailable with the standard precordial leads (Sobieszczkańska, 2005). The BSPM method, holding its unique spatial sensitivity to the regional cardiac events, which is caused by the large number of the exploring electrodes, could be used as a complementary procedure for detecting local electrical events. In particular, a sequence of activation and repolarization of the heart in the entire cardiac cycle, which is presented in the maps as a migration of the positive and negative potential areas of specific distribution over the entire thorax, seems to be of great importance while a significant increase in incidence of malignant ventricular arrhythmias in the population of VDT-operators is observed. Non-dipolar distribution of QRST isointegral maps can be a specific indicator of the increased risk of severe ventricular arrhythmias in this population (Abildskov, 1987).

The aim of the present study was to investigate possible intraventricular conduction disturbances in VDT-operators using QRST isointegral maps.

## 2 Methodology

### 2.1 Material

The investigations were performed in the total number of 80 subjects enrolled after taking the informed consent to the following study groups: group I was constituted by the 40 persons (age range: 20-25 years; 12 females and 28 males) working with computer from 5 to 8 hours every day (VDT-operators), in whom a feeling of heart

**Table 1.** Characteristics of group I and group II

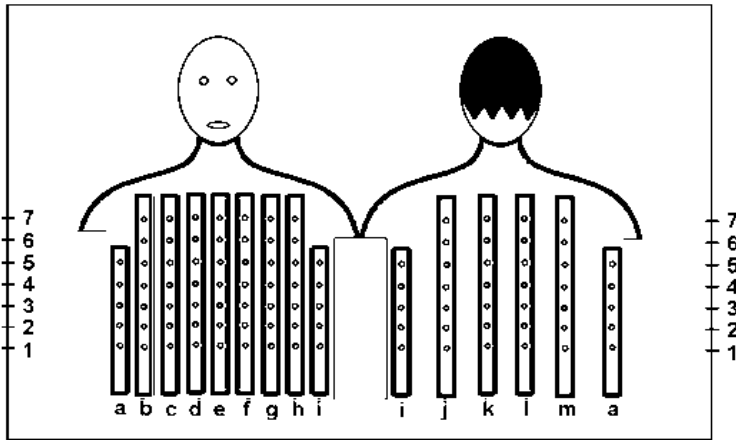
Parameters	Group I	Group II	P
Mean age [years]	24.3 ± 1.71	23.8 ± 1.57	NS
M/F [%]	70/30	70/30	NS
BP <sub>S</sub> [mm Hg]	123.5 ± 17.51	122.8 ± 15.19	NS
BP <sub>D</sub> [mm Hg]	78.4 ± 8.63	75.6 ± 7.94	NS
Conventional ECG	No abnormalities	No abnormalities	–
Somatic symptoms	Heart palpitations	Free from symptoms	–

N – number of subject; M – male; F – female; BP<sub>S</sub> – systolic blood pressure; BP<sub>D</sub> – diastolic blood pressure; NS – not significant; p – probability.

palpitations was common somatic symptom. The group II, serving as a control one, comprised 40 persons (age range: 20-25 years; 12 females and 28 males) who worked with computer occasionally, and were age- and sex-matched. Characteristics of these subgroups are compiled in Table 1.

**2.2 Method**

In the all study persons, the recordings of BSPM were performed using a specialized HPM-7100 Fukuda Denshi system (Japan) composed of the central unit, microprocessor HP-710, 16-inch screen and preamplifier IB-300. The system performs the simultaneous registrations from the 87 specific mapping leads. A frequency of the ECG signals sampling was 1000 samples/s for each of the used channels (Fukuda Denshi, 1990). The electrode standardized array was applied using one-use electrodes placed on 13 adhesive strips mounted in rows on the anterior and posterior thoracic surfaces (designated on the maps the letters A to M), as displayed in Figure 1.



**Fig. 1.** Scheme of electrodes placement on the thoracic surfaces

Data collected from the 87 ECG waveforms were graphically presented as the body surface maps of various formats. The isointegral maps (Int-QRST) represent a summation of the all instant heart potentials and contain a global characteristics of the cardioelectric field within the assigned time interval of the cardiac cycle. This sort of maps reduces significantly an abundant load of the ECG information provided by the isopotential maps.

The investigation protocol was approved by the local Bioethics Committee.

### Statistical Analysis

Standard statistical Student t-test was applied for comparison of the two variables. The values are presented as the mean  $\pm$  SD, and a level of statistical significance was set at  $p < 0.05$ . Non-parametric data was given as the absolute numbers or percentages.

### 3 Results

The long-term investigations carried out in the Department of Pathophysiology of Wroclaw Medical University were aimed at establishing the patterns of the isopotential maps for 95 healthy subjects. Next, the isointegral maps for the whole

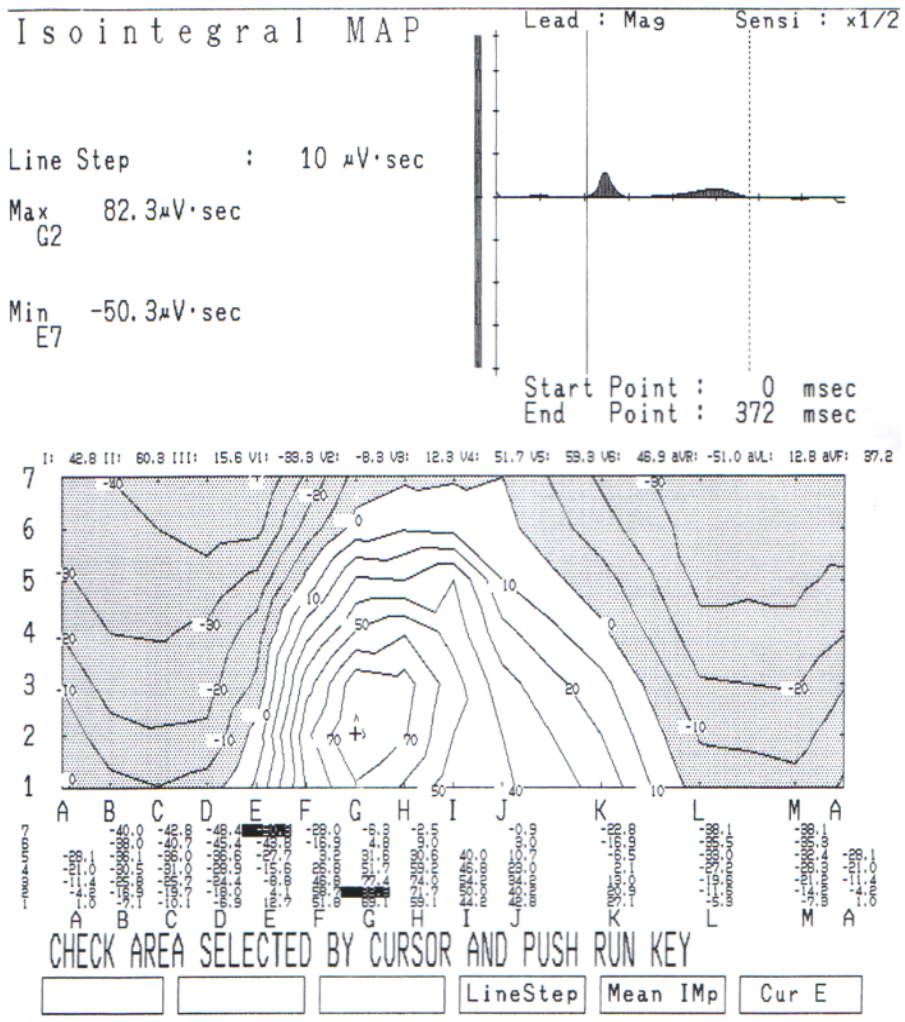


Fig. 2. Int-QRST group-mean map established for 95 healthy subjects

cardiac cycle (Int-QRST) averaged for these subjects were elaborated. In the group-mean (pattern) Int-QRST map established for this group, bipolar distribution was observed (Fig. 2).

The subsequent figures show the example of Int-QRST maps obtained in group I (Fig. 3) and group II (Fig. 4).

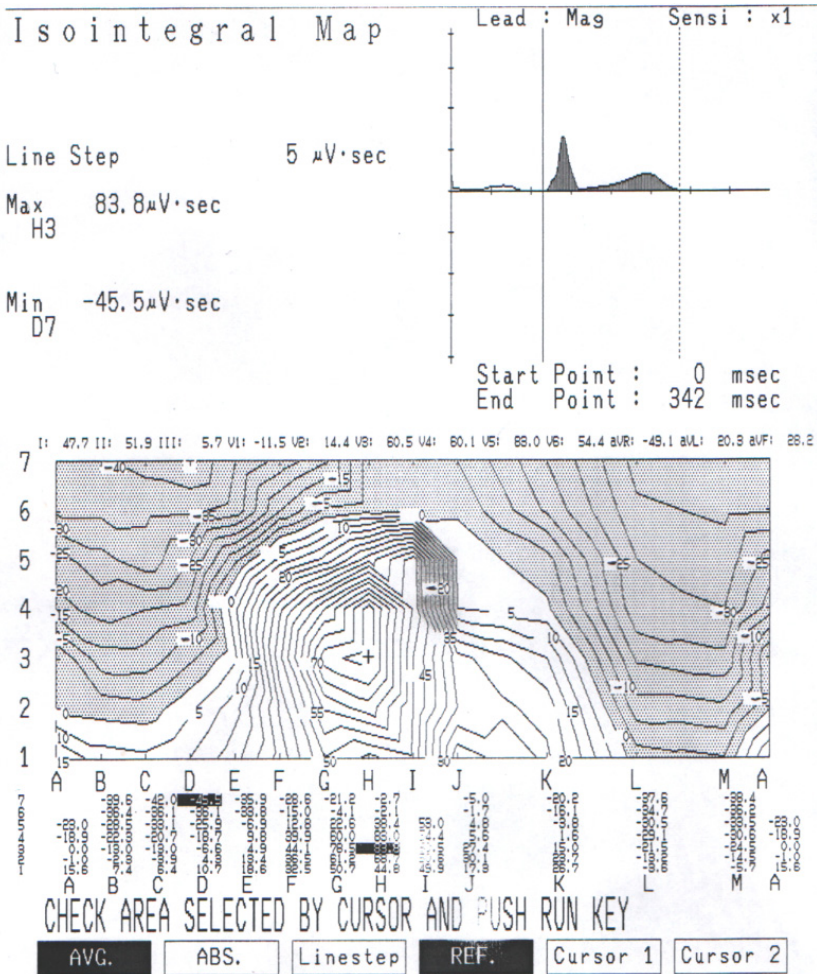


Fig. 3. Multipolar Int-QRST map obtained in the group I

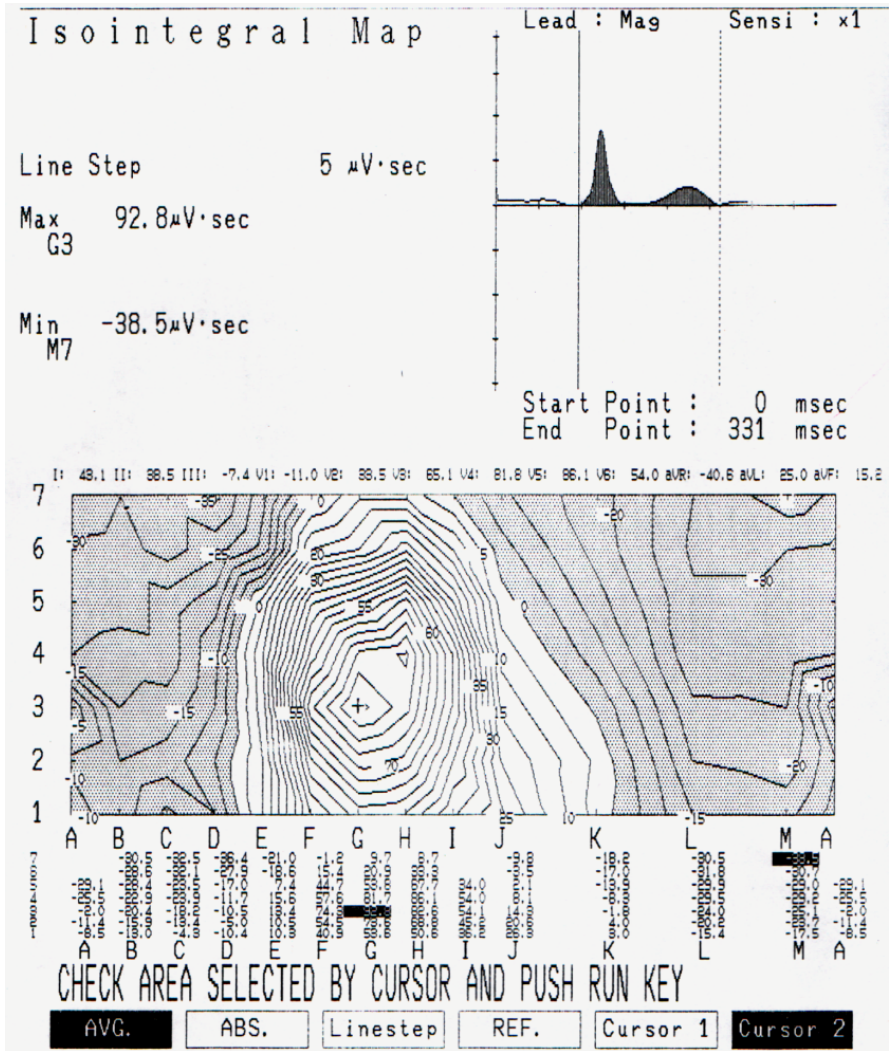


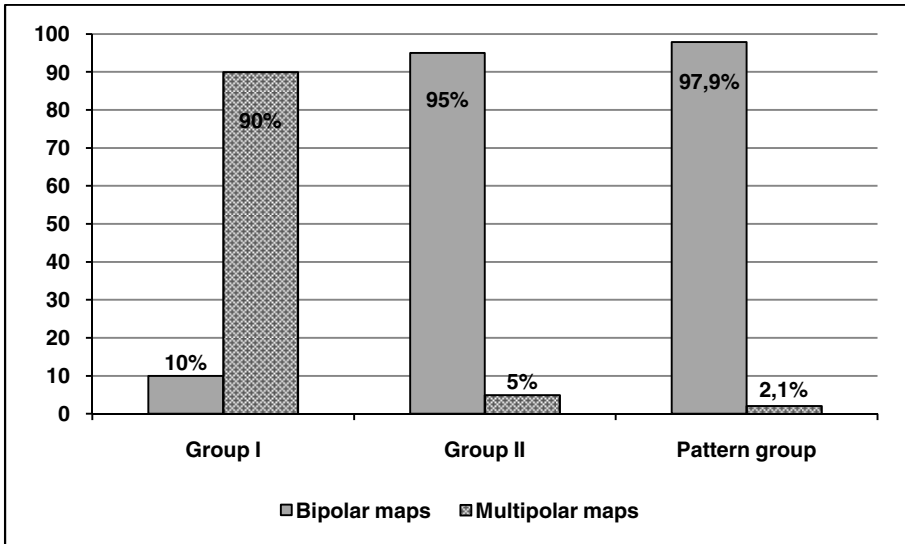
Fig. 4. Bipolar Int-QRST map obtained in the group II

The group-mean Int-QRST map contains both quantitative parameters (the values of potential maximum and minimum) and qualitative parameters (the extremums location) and constituted the reference for the maps obtained from the VDT-operators (group I) and persons from group II working with computer occasionally. Comparison of the mentioned parameters presented on those maps with the pattern map are compiled in Table 2.

**Table 2.** Quantitative and qualitative parameters of Int-QRST maps obtained in group I, group II and pattern map

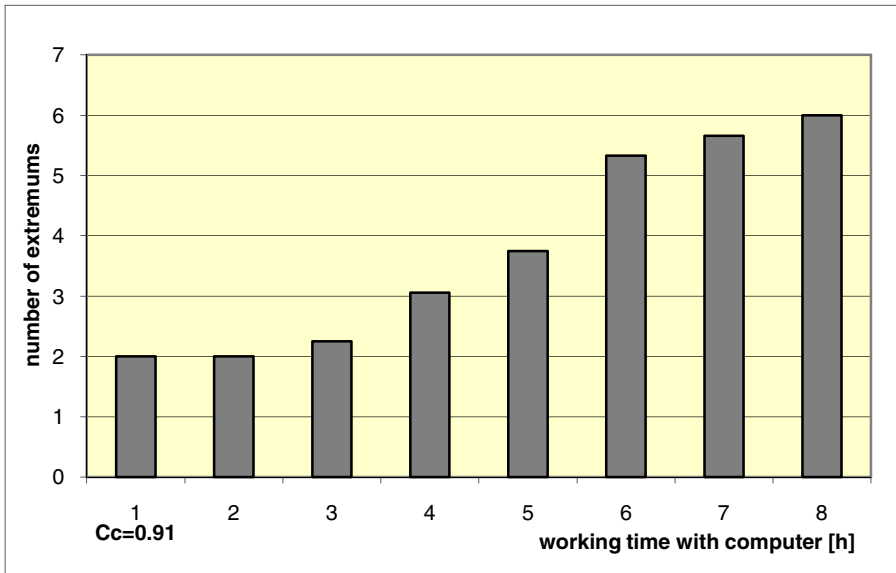
Parameters	Group I	Group II	Pattern map
Mean numbers of extremums	3.53 ± 1.14 (2-8)	2.05 ± 0.22 (2-3)	2.03 ± 0.23 (2-4)
Potential max:			
mean value	83.8 μV·sec	92.8 μV·sec	82.3 μV·sec
location	H3	G3	G2
Potential min:			
mean value	-45.5 μV·sec	-38.5 μV·sec	-50.3 μV·sec
location	D7	M7	E7

The percentage of normal and abnormal Int-QRST maps in the group I, group II and the pattern group are presented in Figure 5.



**Fig. 5.** Percentage of bipolar and multipolar maps in groups I and II and in the pattern group

Mean number of extremums showed a clear tendency to increase gradually with time of dialogue with computer. This relationship is presented in Figure 6.



**Fig. 6.** Correlation between number of extremums and working time with computer in the VDT-operators. Cc – correlation coefficient

## 4 Conclusions

Everyday long-term contact with computer screens is an occupational risk, which induces various undesirable health consequences, including subjective complaints of circulatory system. A method of BSPM showed a high sensitivity with regard to local changes of the cardioelectrical field in the VDT-operators who suffered from a feeling of heart palpitations (Tab. 1).

The quantitative and qualitative parameters as well as the mean number of potential extrema of Int-QRST maps obtained in groups I and II were compared to the mean-pattern map (Tab. 2). In the group I 90% of analyzed maps had abnormal parameters (Fig. 3), however 10% of the Int-QRST maps were considered as normal (Fig. 5). The group II revealed in 95% the normal maps (Fig. 4), but 5% of the analyzed maps showed an abnormal distribution in the isointegral format, whereas in the pattern group 97,9% of the Int-QRST maps were considered as normal (Fig. 2 and 5). Our observations are supposed to be the direct implications of the exposure of the VDT-operators to the harmful occupational factors resulting in number of extremums (Fig. 6).

The results obtained in group I are considered as a reflection of the local ventricular repolarization dispersion (undetectable on the standard 12-lead ECGs), which indicates an increased risk of serious ventricular arrhythmias.

In the group II, the number of potential extrema were significantly lower ( $p < 0.001$ ) than in the group I and near the number of potential extrema on the



reference map (Tab. 2). In the persons from group II, without concomitant conditions, QRST isointegral maps presented a normal bipolar nature (two extrema), although, as compared with the pattern map, the statistically significant differences were found concerning the values of extrema (maxima and minima), which also suggested slightly increased arrhythmogeneity in this group.

The BSPM method could be considered as an additional tool for detecting local electrical events. In particular, a sequence of activation and repolarization of the heart in the entire cardiac cycle, which is presented in the maps as a migration of the positive and negative potential areas of specific distribution over the entire thorax seems to be of great importance while a significant increase in incidence of malignant ventricular arrhythmias in the population of VDT-operators is observed. Non-dipolar distribution of QRST isointegral maps can be a specific indicator of the increased risk of severe ventricular arrhythmias occurring prior to abnormalities detectable on the standard 12-lead ECG recordings, which is of great importance especially in prevention of life-threatening arrhythmias (Sobieszcańska, 2005; Abildskov, 1987).

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