Study on the autonomic regulation analysis of cardiovascular system using non-invasive and ambulatory system for monitoring instantaneous blood pressure and cardiac interbeat interval

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Research Project

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06454722

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Grant-in-Aid for Scientific Research (B)

Allocation Type

Single-year Grants

Section

一般

Research Field

Biomedical engineering/Biological material science

Research Institution

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Non-invasive and ambulatry cardiovascular monitoring / Cardiovascular regulatory function / Autonomic regulation / Sympathetic / vagal nerve activity / Baroreceptor-cardiac reflex / Volume-compensation method / Instantaneous blood pressure / Spectral analysis

Research Abstract

In order to analyze autonomic regulation of cardiovascular system during daily life activities, a non-invasive and ambulatory system (160x140x45mm, 700gf) has been newly designed, which can automatically monitor systolic (SBP) /mean (MBP) /diastolic pressure (DBP), pulse interval (P-P), inter-beat interval (IBI) and respiration interval (ReP) from ECG waveform on a beat-by-beat basis. Principle of blood pressure measurement is based on the volume-compensation method using vascular unloading, previously proposed by us. 6 time-series data are recorded in an IC memory card after necessary signal processings using a single-chip microcomputer with an interactive software, altogether about 700,000 beats of data being stored. After the monitoring, these stored data are reproduced, displayd on a CRT monitor, and performed necessary analyzes using a conventional personal computer. Taking physiological importance of the effect of human posture changes on the cardiovascular variables into conside ration, a portable instrument for long-term ambulatory monitoring of the posture chnges has been also designed in parallel with the development of the present system. This measurement is based on the fact that almost all human postures in daily life can be estimated from the angles corresponding to the gravitational direction in three portions ; chest, thigh and lower leg. The instrument (58x94x25mm, 130g) can store these angles in a CMOS RAM (2MB) using electro-magnetic inclinometers placed on the three portions, and easily be used together with the above system if rewuired under an experimental situation.
In this study, autonomic regulatory function of the cardiovascular system was assessed by (i) baroreceptor-cardiac reflex sensitivity (BRS) obtained by computerised scanning of beat-by-beat SBP and PP (or IBI) values, (ii) transfer function calculated by power and cross spectra of SBP and IBI data, and (iii) spectral analysis of SBP and IBI data using a naximum entropy method, which were performed by a personal computer-based system. Using young (20-24 years old, male) healthy subjects, data were collected under daily life activities and categorized into 9 physical activities ; supine (rest), siting (rest), desk work on a chair, standing, working during standing without movement, walking, up and down the stairs, and bicycle exercise. It is demonstrated that the BRS values and power spectral density of IBI data over high frequency (HF) range of 0.15-0.5 Hz were significantly reduced following the increase in the physical activities, indicating that vagal nerve activity would be depressed by the increase in the physical activities. This phenomenon was also confirmed by the gain of the transfer function at higher values of the coherence over low frequency (LF) range of 0.04-0.12 Hz and HF range. However, power spectral densities of IBI and SBP data over LF range showed no significant correlation with the physical activities, indicating that LF powers of both SBP and IBI might be modulated by the vagal and sympathetic nerve activity against the physical activities and thus not be a significant index to assess only the sympathetic activity. Through these findings, we conclude that further development of ambulatory system capable of monitoring both blood pressure and cardiac output (and thus peripheral vascular resistance) should be desired to evaluate in detail the sympathetic activity during daily life.▲ Less

Research Products (17 results)

All | Other

All | Publications (17 results)

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