연령별 그룹의 정서적 스트레스 지수와 심박미세변이

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Emotional Stress Factors and Heart Rate Variability in Different Age Groups

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Stress is a physiological and psychological response to events that may alter our autonomic nervous function. Autonomic nervous system (ANS) can be monitored by heart rate variability (HRV). Thus, stress may be measured by HRV. The ANS is divided into two main divisions: sympathetic and parasympathetic nervous system. These are simultaneously operated and balanced each other in healthy subjects. Sympathetic nervous system becomes more active under mental stress. It increases heart rates, the activity of adrenal glands, and breathing rates. Parasympathetic nervous system acts in opposite to sympathetic nervous system. The interaction between sympathetic and parasympathetic nervous system leads to the variation of beat-to-beat intervals and eventually handles or recover from the stress. Stress response inventory (SRI) has been recently devised to score the severity of mental, physical, and emotional symptoms caused by stress. In the SRI, stress factors are categorized into seven parts: tension, depression, fatigue, somatization, frustration, aggression, and anger. Among them, frustration, aggression, and anger are emotional symptoms. In this study, we focused on emotional stress factors and their relationship to HRV features.

Data used in this study were obtained from the experiment involved 360 subjects from 20's to 60's of age. Subjects filled out a simplified version of SRI questionnaire which was composed of 22 question. After completing the SRI questionnaire, subjects underwent the measurement of heartbeat signals that were obtained by the photoplethysmography (PPG) sensor. Three minute records of heartbeat were obtained and fifteen HRV metrics were calculated from the heartbeat interval data. In one of our previous studies, the age was one of significant factors that affects stress factors and HRV features. In this study, the age was factored out by separating subjects into different age groups. By using the k-means clustering method based on Euclidean distance (StatGraphics Plus V4.1, Manugistics, Inc, Rockville, MD), total subjects were divided into three different age groups(class 1: 20~31, class 2: 32~44 and class 3: 45~69 of ages) ($p < 0.05$). Each group was further divided into high and low stress groups also by using the clustering method based on the sum of the emotional stress factor scores. Then, the correlation of emotional stress scores and HRV features were evaluated by Pearson's correlation analysis (StatGraphics Plus V4.1). HRV features in low and high stress group were compared by Mann-Whitney test (StatGraphics Plus V4.1).

In result, none of classes showed any significantly correlated HRV features with frustration features (p>0.05). While, anger factors were weakly but significantly correlated with HF (ρ=-0.17, p<0.05) and aggression factors were correlated with LFnu (ρ=0.21, p<0.05) and HFnu (ρ=-0.21, p<0.05). The weak but significant correlation of these features indicated that emotional stress may be related to ANS activities and monitored by HRV analysis. High emotional stress group tend to show higher LF/HF and LFnu and lower HF, HFnu, HRVIndex, and TINN. LF and LFnu are mainly influenced by sympathetic activity which high emotional stress group may naturally have elevated values. On the other hand, HF and HFnu are mainly influenced by parasympathetic activity which low emotional stress group may have elevated values. LF/HF reflects the predominance of sympathetic over parasympathetic activity that high SRI may have a large median values. By using these HRV features showing differences between low and high stress group, the decision tree can be obtained with the similar correct classification rate compared to the decision tree which considers all the HRV features. It would be advantages to reduce the computation time and helpful for mobile healthcare applications. In this study, the significant HRV features related to emotional stress levels have been obtained. In the case of frustration and anger stress factors, it is still unknown whether HRV features were significantly related due to the lack of evidences in all age groups. In the case of aggression stress factor, it has enough evidences that suggest the instantaneous emotional stress status might be estimated by measuring the HRV features. Since the stress questionnaire cannot be used frequently, HRV analysis could be more adequate for mobile applications.