A Comparative Study between Females of Pre-Pubertal and Reproductive age groups to explore how HPG-Axis affects the Autonomic Control over Cardiac Activity

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Abstract

Heart rate variability (HRV) is the natural rise and fall of beat-to-beat variation of heart rate in response to breathing, blood pressure, hormone levels and even emotions [1]. HRV reflects the heart’s ability to adapt to changing circumstances by detecting and quickly responding to various stimuli. HRV analysis can assess the overall cardiac health and the balance between sympathetic and parasympathetic regulation on cardiac activity- the two main components of the ANS (Autonomic Nervous System). Gonadotropic hormones such as FSH (follicle-stimulating hormone), LH (Lutenizing Hormone) and Gn-RH (Gonadotropin-releasing hormone) are known to affect this balance. This method has proved to be of great clinical usefulness in studying several pathological conditions due to the hormonal imbalance in women. HRV means the variability over time in the time gap between identical events in the consecutive cardiac cycles. Now-a-days it has become possible to study beat-to-beat variation of R-R intervals with the aid of digital computers from the electrocardiogram (ECG) recordings. HRV index is defined as the ratio between the power of low frequency and high frequency component of the ECG signal. In here the authors present a comparative study between females of pre-pubertal and reproductive age groups to explore how Hypothalamus-Pituitary-Gonadal (HPG) axis affects the autonomic control over cardiac activity.

Key words: Heart Rate Variability, Autonomic Nervous System, Gonadotropic hormone, Electrocardiogram, HPG axis.

1. Introduction

This paper reports a study on the effect of female HPG axis on the autonomic control over the cardiac activity using HRV analysis. HRV is the natural rise and fall of beat-to-beat heart rate (HR) in response to breathing, blood pressure, hormones and even emotions. In a healthy heart, the rate should increase as a person inhales and decrease as s/he exhales. HRV is reflective of the general wellness state of the organism. It is generally studied as the variation over time of the period between consecutive heartbeats, and; is predominantly dependent on the extrinsic regulation of the heart rate. HRV is thought to reflect the heart’s ability to adapt to changing circumstances by detecting and quickly responding to unpredictable stimuli. HRV analysis’ ability to assess overall cardiac health and the state of the ANS responsible for regulating cardiac activity underlies in its promise as a major new tool in the diagnostic and monitoring armamentarium.

Either the anterior pituitary gland or the placenta that have various effects upon the ovaries and testes releases gonadotropic hormone or gonadotropin. Gn-RH is produced
and released from the hypothalamus. Gn-RH release stimulates the secretion of both FSH and LH from the pituitary gland. Gn-RH is a peptide composed of ten amino acids, which are synthesized in the hypothalamus. This hormone travels in the bloodstream to the anterior pituitary, where it causes the release of the gonadotropic hormones. The hormones FSH and LH inhibit the amount of Gn-RH released by a mechanism called "negative feedback." In the female, FSH causes an increase in the weight of the ovaries and encourages the growth of Graafian follicles (containing maturing eggs). In females, secretion of LH is associated with the maturation of the follicles, the manifestation of heat (or estrus), and the release of the egg from the follicle, which is transformed into a corpus luteum. Sex hormones released from the ovaries eventually reach the hypothalamus and help to regulate the hormonal cycle.

The heart is an organ under the influence of the ANS for the maintenance of homeostasis, and, in this respect, one of its main characteristics is the constant modification of its rate on beat-to-beat basis. Also, it should be emphasized that HR is a variable that can be measured in a noninvasive manner with minimal error using simple and low-cost equipment. Today, with the aid of digital computers, it has become possible to study beat-to-beat HRV obtained from the R-R intervals in the ECG recordings. This method has proved to be of great clinical usefulness to evaluate the balance of sympathetic and parasympathetic regulation in several pathological conditions due to the hormonal imbalance for women.

The aim of this project is a comparative study of the hormonal status based on HRV recording between the pre-pubertal and reproductive age group of women. Another purpose is to find out a non-invasive way to indirectly monitor the fluctuations in the level of hormones in female and associated clinical problems.

Our approach is to first revisit the relationship between the functioning of the ANS and HRV through ECG Signal Processing. The next is to identify the parameters obtained from the ECG recording that would reflect the fluctuations of female hormone levels in the pre-pubertal and reproductive age group of women.

2. Materials

For this project we made use of an ECG data acquisition device along with a questionnaire to assess the general condition of the subject. Afterwards we took help of some standard software for processing of the acquired data. For this experiment reading of the subject is taken from two groups of women—

i) Pre-pubertal group
ii) Reproductive age group

3. Methodology

i) The experimental procedure is explained to the participants and the questionnaire form is filled up by them.

ii) The ECG reading of subjects is taken by ECG data acquisition device for 5 minutes.

iii) The ECG data is acquired by NI software through PC.

iv) Process the ECG data through MATLAB® and HRV Analysis software®.
v) Analyze the processed ECG data for comparing the said two groups to find out the hormonal difference between those two groups.

4. Results

For this project two different groups of women are selected. They are pre-pubertal age group (Age: 10±2 (MEAN±SD)) and reproductive age group (Age: 22±3). For the HRV study we selected 10 women for each group. At first we took the ECG reading of the subjects, then found out the R-R interval through algorithm and finally found out the HRV parameters. Then from the statistical analysis of those parameters we can conclude that there is a significant difference between the said two groups of females with respect to their overall HRV status. In terms of hormonal status they are notably different as well as in terms of HRV they are also significantly different. After doing ANOVA we have observed that for Very Low Frequency (VLF) P-value is 0.0268, for Low Frequency (LF) P-value is 0.0029, for High Frequency (HF) P-value is 0.4303, for LF/HF ratio 0.29261. As we would increase the number of sample size then the difference between these two groups with respect to HRV status is expected to become statistically more significant.

5. Discussion

In here a significant difference between the said two groups of females is observed with respect to their overall HRV status. It is well-known that the said two groups differ grossly in terms of their hormonal status of the HPG axis. In pre-pubertal group the menstrual cycle has yet not been started whereas in the reproductive age group the HPG axis is very much active. This finding seems to point towards a very important implication that there appears to be a correlation between the hormonal levels in female HPG axis and the ANS control of their cardiac activity.

References

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