Comparison Between Parasympathetic and Sympathetic Balance for Synchronously Registered HRV and EGG Signals in Case of Non-calorific Water Load

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1 Introduction

Electrogastrographic Signal (EGG) is considered to be one of the less interesting from both registration and interpretation point of view. There are several reasons of that two facts. EGG presents gastric myoelectrical activity measured by several electrodes attached on the abdomen. Unfortunately the registration procedure does not deliver a pure signal as EGG is usually associated with some interferences caused by the other organs localized near stomach. On the other hand however, there are no databases available, which could allow both comparison and proper interpretation.
The source of EGG [1] signal is the stomach, which similarly like other elements of gastrointestinal system is made of parallel positioned, mutually connected muscle layers. From the EGG signal point of view, human stomach is made of special muscle membrane frequently called muscular coat, consisting of three layers: external longitudinal, middle circular and finally internal oblique, which due to mutual close specific connections can commonly work as electric signal network. Longitudinal layer cells create a dominant cluster of cells along both curvatures and does not appear in the front and back walls of stomach [3]. The place where longitudinal layers miocytes are separated is considered to be a pacemaker capable for automatic self excitation. Generally, there are two types of muscle electrical activity inside the stomach: Electrical Control Activity (ECA) or so called slow wave and Electrical Response Activity (ERA) [5]. Slow waves are spread out from one cell to another of longitudinal layer causing electrotonic currents in the circular layer. Slow waves frequency is around 3 cycles per minute ([cpm]) and do not produce contractions of the stomach muscles. It is possible to assert that slow waves both integrate and control stomach wall muscularis contractions. Stomach muscularis contraction is produced by ERA, which can only appear at the top of depolarization of the slow wave.

2 Methods

EGG signal registration has been performed with the standard biosignal amplifier and abdomen electrodes placement [fig.1].

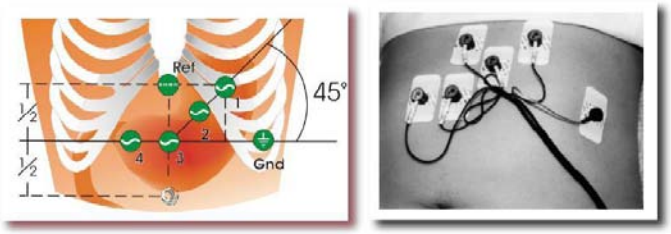

Fig. 1 Electrode placement for 4-channel EGG signal registration

The presented configuration of electrodes allow for registration of standard ECG signal and in fact that signal plays a dominant role in most body surface registrations. Extraction of EGG from already registered ECG requires quite sophisticated signal processing based upon the application of proper filters cascade [fig.2] [7].

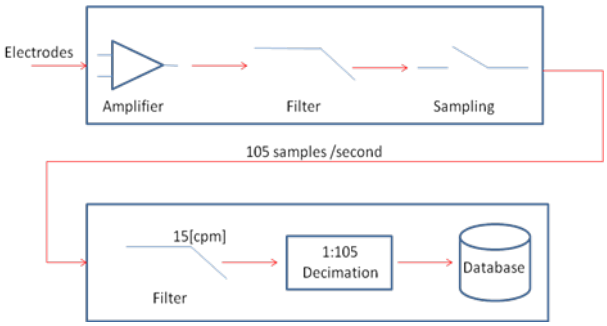

Fig. 2 Basic preprocessing applied for EGG recordings

Having both ECG and EGG signals available, it is relatively easy to formulate another very important signal under investigation, namely heart rate variability (HRV) signal. It has been done according to well known recommendations summarized in [4]. Registration has been performed for 12 healthy patients and after application of 400 ml of mineral non-carbonated water. Duration of the registration procedure has also been with perfect agreement to existing standards i.e. 5 minutes[3].
So called rhythmicity included in both signals under investigation is naturally observed in case of HRV, however in case of EGG that parameter is considered similarly like in cardiac signals i.e. one can extract brady-, tachy-, and normogastrias. The most know examinations in literature [2,6,7] concern the analysis of normogastria. Therefore the next step performed refer to calculation of power spectral density (PDS) separately for both parts of autonomic nervous system (ANS) i.e. sympathetic (SNS) and parasympathetic (PNS) using principal dynamic modes (PDM). The details of the calculations can be found in [7].

3 Results and discussion

Looking for the proper pointer allowing estimation of both part of ANS influence separately i.e. SNS and PNS it seems that integral of PSD calculated in the defined frequency ranges should be considered as a good enough estimation. The mentioned frequency ranges are the following:

- Bradygastria less than 2.5[cpm](0.042 [Hz])
- Normogastria between 2.5–3.7[cpm](0.042–0.062 [Hz])
- Tachygastria more than 3.7 [cpm] (0.062 [Hz]).

The total PSD integral has been calculated up to the fastest possible gastric rhythm i.e. up to 0.2 Hz. We have calculated the average between particular channels for four-channel EGG signal as well as average of HF and LF frequencies for HRV.
The results obtained have been quite unexpected, as the balance between both parts of ANS in case of examined signals is reciprocal i.e. if sympathetic part is privileged in comparison to parasympathetic one for HRV signal, then the balance for ECG normogastric rhythm is reversed. Looking for the interpretation of that mentioned above fact the only one possibility is reasonable i.e. the delay required during gastrointestinal procedures that need to last several minutes even after non-calorific water load. More, having a multichannel system for EGG registration the SNS/PNS

balance changes according to the direction of wave propagation. The results obtained can be seen on fig.3 and fig.4.

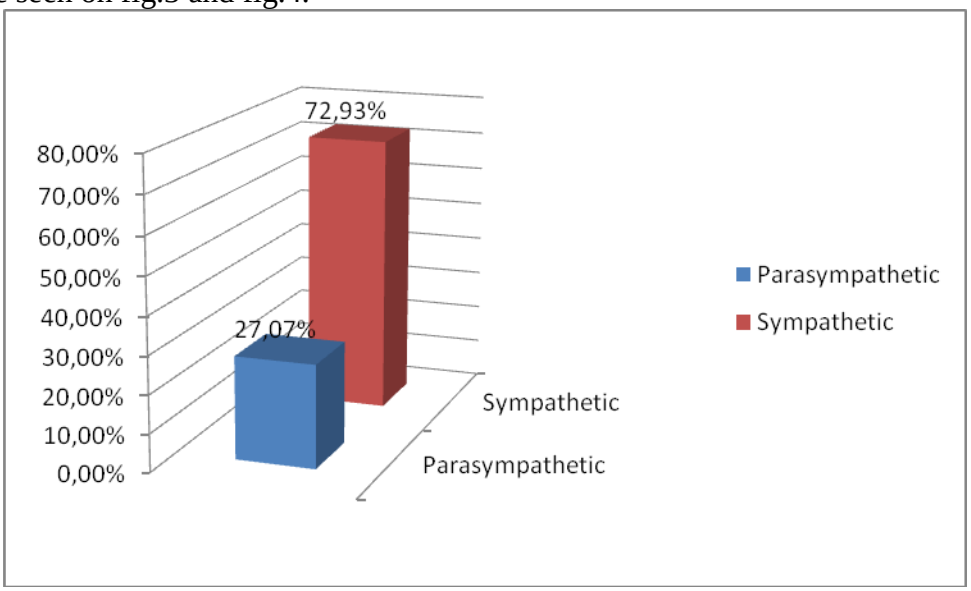

Fig.3 The example of average balance between SNS and PNS for HRV signal

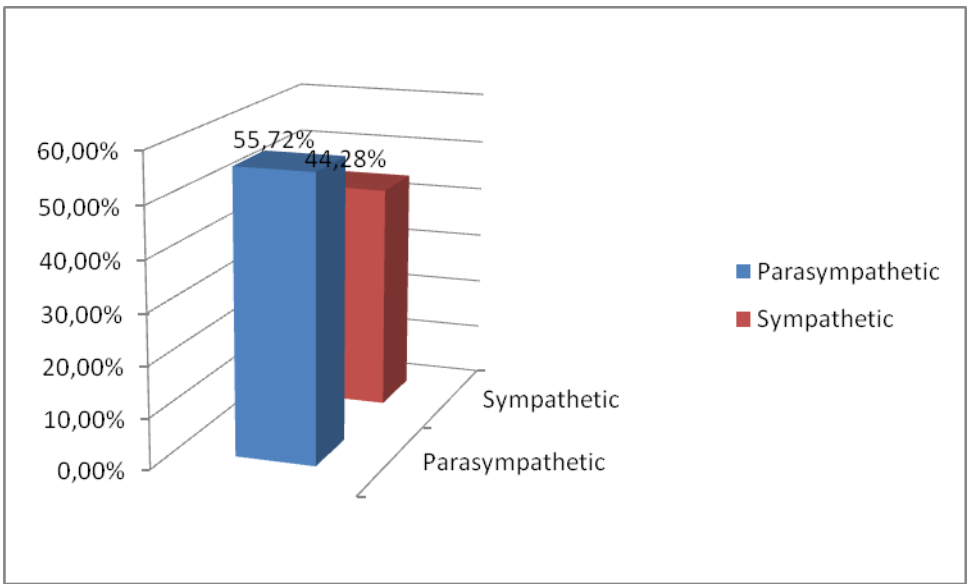

Fig.3 The example of average (four channels) balance between SNS and PNS for EGG signal

The presented results show that there is a sort of different influence of ANS for human body different systems even when registration procedure is performed synchronously. Definitely it requires further extensive study leading to elaboration of set of proper parameters for both quantitative and qualitative interpretation.

4 Conclusions

In this paper we have made an attempt of both EGG and HRV common examinations with regard to ANS influence, more precisely with regards of separate influence of SNS and PNS. The examinations have been performed with calorific-less water load according to elaborated registration procedure. As the results of such examinations we

have discovered that the mentioned influence is different or in other words reciprocal considering balance between SNS and PNS for both examined signals. The explanation of that discovered fact is unfortunately far from being easy and it needs to include several physiological mechanism of different origin, which probably will help to find the right explanation. In any case the presented study require further registration, examination and interpretation.

References

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