SPECTRAL ANALYSIS METHODS OF HEART RATE VARIABILITY FOR EARLY NON-INVASIVE IDENTIFICATION OF PREECLAMPSIA IN OMANIS

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Abstract

Preeclampsia disease (PE) is a disorder of pregnancy characterized by high blood pressure and significant amounts of protein in the urine. It is defined as having a blood pressure greater than 140 mm Hg systolic or 90 mm Hg diastolic, plus protein in the urine greater than 300 mg. Blood pressure measurements are done at least twice, 6 hours apart after the 20th week of gestation (in 2nd and 3rd trimesters). Hypertension is a core vital sign for the diagnosis of PE. Clinical measurement of blood pressure can be accomplished both invasively and non-invasively. Invasive BP measurements are reliable and highly sensitive to BP changes. However, it requires arterial access and is restricted to a hospital setting. Non-invasive BP measurement is a conventional method for measuring BP. Although it is simple and fast, the obtained readings are dependent on the patient position and are not accurate. Thus, the need to develop a new non-invasive method for the detection of Preeclampsia disease has become essential. In this direction, many researchers proved that the variations in the cardiovascular regularity behavior (sympathetic and parasympathetic) during pregnancy and Preeclampsia can be used for the diagnosis of Preeclampsia. Our aim in this project is to prove this fact using data collected from Omani subjects and to design a non-invasive diagnosis tool based on the spectral analysis of the Heart Rate Variability (HRV).

ECG records for 20 preeclamptic patients and 20 normal subjects were acquired from Nizwa Hospital and Sultan Qaboos University Hospital (SQUH) in Sultanate of Oman. R-R interval (RRI) data were extracted from these ECG records using QRS detection software provided by Physionet. In this thesis, two main analysis methods were implemented to discriminate between normal and preeclamptic pregnant subjects: Fast Fourier Transform (FFT) and Wavelets Packets.

Using the FFT method with the spectra of the 3 main sub-bands of the HRV, the LF parameter yields equal sensitivity and specificity of 80% with an accuracy of 80% also. Using the LF/HF ratio, the sensitivity, specificity, and accuracy were 70%, 85%, and 77.5%, respectively. In the FFT method with the spectral of 10 sub-bands, B2 (0.05-0.1 Hz) yielded sensitivity of 70%, specificity of 90%, and accuracy of 80%. In the Wavelets packets with 16 bands using COIF3 filter, the best results were achieved using the LF power and the LF/HF ratio. Using the LF power, the sensitivity, specificity, and accuracy were 80%, 75%, and 77.5%, respectively. The LF/HF ratio sensitivity was 70%, specificity was 85%, and accuracy was 77.5%. Wavelets Packets with 32 bands using COIF3 filter yielded the best results using the LF power. The sensitivity, specificity, and accuracy were 90%, 65% and 77.5%, respectively.
In conclusion, it has been noted that the Preeclamptic group has lower power spectral density in the HF band but higher power spectral density in the LF band compared to the normal pregnant group. Our results prove that normal pregnancy is associated with a facilitation of sympathetic regulation and an attenuation of parasympathetic influence of heart rate.