Analysis of the Heart Rate Variability and Ventricular Repolarization During Pregnancy and After Labour

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Abstract

This work investigates the time course of the ECG parameters affected in pregnant women during pregnancy and after labour through the analysis of heart rate variability and ventricular repolarization. In 29 pregnant women, three stages have been studied: 1) At 6 months (6MP); 2) At 9 months (9MP); 3) One month after labour (1ML). Time- and frequency-domain parameters were evaluated on 24-hours Holter ECG recordings, for diurnal and nocturnal periods. Obtained results show: 1) 9MP vs. 1ML provides significant differences of parameters in time- and frequency-domain at diurnal and nocturnal periods. 2) Only ventricular repolarization parameters can distinguish 9MP and 6MP during nocturnal periods. (3) 6MP vs. 1ML only show significant differences of parameters in time- and frequency-domain during nocturnal periods. In conclusion, parasympathetic influence on heart rate variability decrease with time during pregnancy, reaching its minimum in the last month and recovering after labour.

1. Introduction

During gestational period, several modifications of cardiovascular parameters are produced, mainly due to hormonal and circulation changes. There is an increase in blood pressure and heart rate and, in some cases, ECG may show alterations on ventricular repolarization. Cardiovascular autonomic modulation is markedly depressed during normal pregnancy [1,2].

Heart rate variability (HRV) analysis has proven to be a good quantitative index for the autonomous cardiovascular activity, thus, it is used as a marker in many different pathologies. However, it is necessary to describe normal values of HRV parameters to use them as markers during normal pregnancy,.

This work investigates the time course of the parameters affected in pregnant women during normal pregnancy and after labour through the analysis of heart rate variability and ventricular repolarization.

2. Materials and methods

In 29 pregnant women, three stages have been studied: 1) At 6 months (6MP); 2) At 9 months (9MP); 3) One month after labour (1ML). 24-hours Holter electrocardiographic monitoring was used (Space Lab model 90205). The signal was digitized with a 250 Hz sampling frequency and 12 bit resolution. The signal processing was done with Matlab® v5.2. The RR and QT series were obtained with a modification of the Laguna algorithm [3].

Two time periods were studied: 1) diurnal (D: 6 hours: 11h-17h), and 2) nocturnal (N: 4 hours:1-5h). The processing steps for the RR and QT series of every period were the following [4,5]:

1. Pre-processing: Detection and elimination of no valid segments and ectopic pulses in the RR and QT series. The ectopic and the following pulse are substituted by linear interpolation [6].
2. Segmentation in 5 minutes RR and QT series, and sampling of the short series.
3. Detrend of the series and spectral and cross-spectral computing by Welch's method.
4. Frequency domain parameters for the 5' RR series are calculated in LF and HF bands (see table 1).
5. Spectral coherence parameters are calculated from the RR-QT cross-spectrum (see table 1).
6. The 5' RR series are undersampled to obtain the long RR series and to compute the total spectrum and the VLF band parameters (see table 1).
7. The time domain RR and RR-QT parameters are calculated (see table 2).

Variable	Description
RR series	
MHF	Maximum frequency in HF
MLF	Maximum frequency in LF
MVLF	Maximum frequency in VLF
PHF	Power in HF range
PLF	Power in LF range
PVLF	Power in VLF range
HFN	HF power in normalized units
LFN	LF power in normalized units
LF/HF	ratio PLF/PHF
RR-QT series	
MMSC_HF	HF band spectral coherence mean
MMSC_LF	LF band spectral coherence mean
MMSC	Total spectral coherence mean
SDMMSC_HF	Mean standard deviation of HF band spectral coherence
SDMMSC_LF	Mean standard deviation of LF band spectral coherence
SDMMSC	Mean standard deviation of total spectral coherence

Table 1. Frequency domain parameters analyzed.

Variable	Description
RR series	
ANN	Average NN intervals over 5 minutes periods
SDNN	Standard deviation of the NN intervals
CV	Variance coefficient: SDNN/ANN
SDANN	Standard deviation of the average NN intervals over 5 minutes periods
RMSSD	Square root of the mean squared differences of successive NN intervals
TRIAN_INDX	Integral of the density distribution divided by its maximum
RR-QT series	
QTVI	QT variability index

Table 2. Time domain parameters analyzed.

Results are given as mean ± SD. Statistical analysis of results has been done using Student's t-test. Probability values $p<0.05$ have been considered statistically significant.

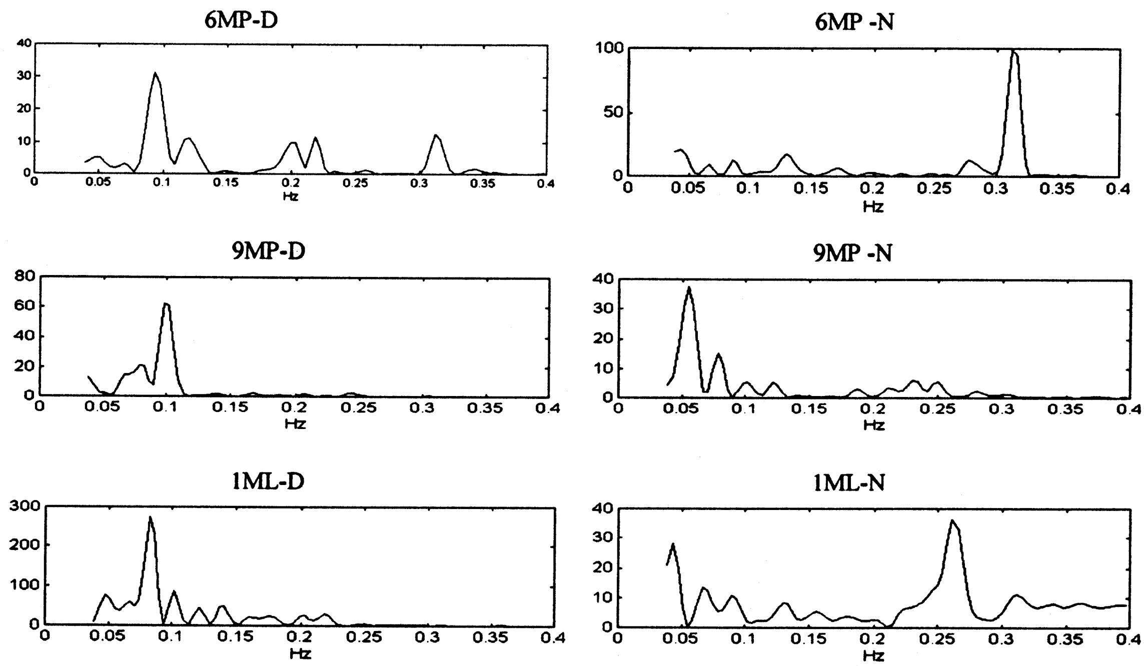

Figure 1. LF and HF bands spectra for 6MP, 9MP and 1ML, and the diurnal and nocturnal periods for the same patient.

3. Results

Figure 1 shows an example of the spectra in LF and HF bands for the three stages in the diurnal and nocturnal periods. The maximum value corresponds to LF band in the diurnal period and HF in the nocturnal, for 6MP and 1ML stages. The 9MP stage shows a maximum in the LF band for both periods.

Figures 2 and 3 show the average values obtained for the studied parameters, for the three stages in function of the period, normalized by the 9MP values. In general, parameters decrease with time during pregnancy, reaching its minimum for the last month and recovering after labour. Specially, parasympathetic influence on heart rate variability, related with HF band, is progressively depressed with pregnancy time course.

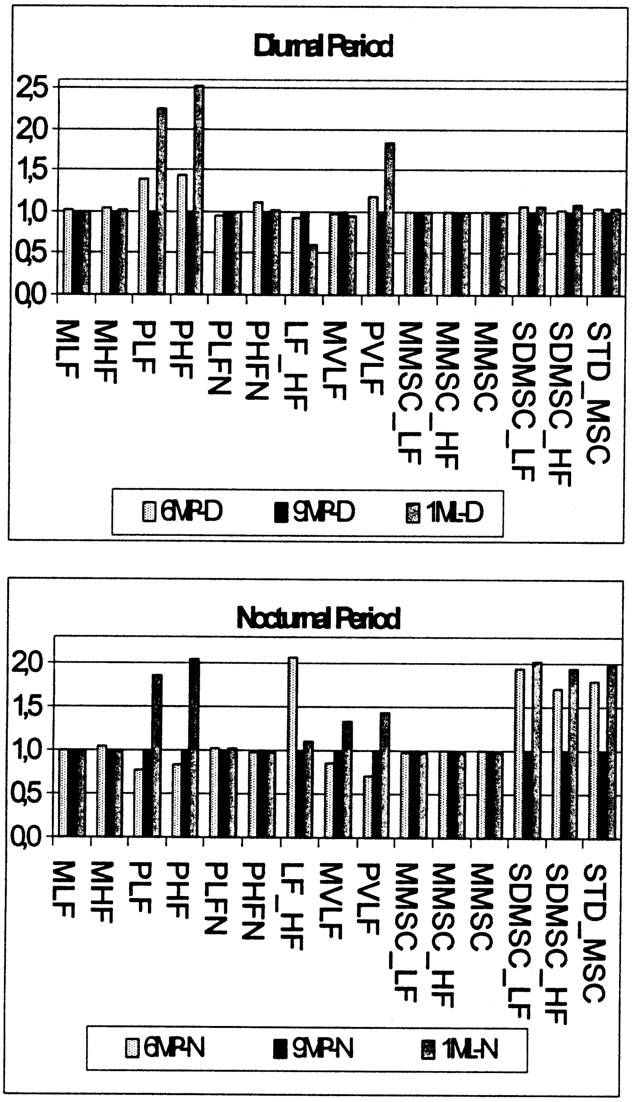

Figure 2. Average values obtained for the frequency-domain parameters, normalized by the 9MP values, for the three stages in function of the period.

The table 3 shows the values (mean ± SD, p) for the parameters showing significant differences between 9MP vs. 6MP, and 1ML.

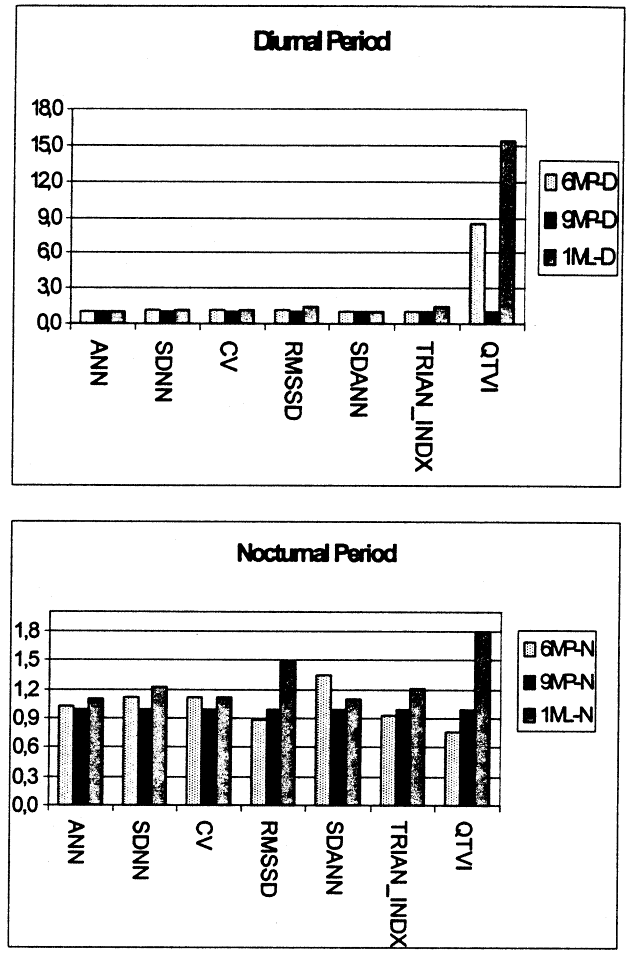

Figure 3. Average values obtained for the time-domain parameters, normalized by the 9MP values, for the three stages in function of the period.

Parameter	**9MP-D**	**1ML-D**	**p**
PLF	50,39±9,46	1893,29±1453,18	**
PHF	233,21± 126,03	587,50±594,86	**
PVLF	4195,94± 3158,48	7737,99±5841,35	*
Parameter	**9MP-N**	**1ML-N**	**p**
ANN	869,10±92,20	963,17±120,61	**
PHF	379,65±356,50	778,73± 849,79	*
MMSC_LF	0,994±0,009	0,985±0,015	**
MMSC_HF	0,993±0,009	0,984±0,015	**
MMSC	0,993±0,009	0,984±0,014	**
Parameter	**9MP-N**	**6MP-N**	**p**
QTVI	-0,29±0,41	-0,22±0,37	*
MMSC_LF	0,994±0,009	0,987±0,013	*
MMSC	0,993±0,009	0,987±0,013	*

Parameter	6MP-N	1ML-N	p
ANN	886,56±92,39	963,17±120,61	*
PLF	612,52±430,95	778,73± 849,79	**
PHF	316,33±236,34	778,73± 849,79	**
PVLF	2151,74± 1544,91	4377,15±5187,65	*

Table 3. Parameters showing significant differences among groups (D: diurnal period, N: nocturnal period; *: p<0.05, **: p<0.01).

4. Conclusions

In this paper, time- and frequency domain parameters of the heart rate variability (HRV) and ventricular recovery (VR) are investigated in 29 pregnant women, at 6 months, 9 months and one month after labour.

We have observed: 1) 9MP vs. 1ML provides significant differences of parameters in time- and frequency-domain at diurnal and nocturnal periods. 2) Only ventricular repolarization parameters can distinguish 9MP and 6MP during nocturnal periods. (3) 6MP vs. 1ML only show significant differences of parameters in time- and frequency-domain during nocturnal periods.

In conclusion, parasympathetic influence on heart rate variability decrease with time during pregnancy, reaching its minimum in the last month and recovering after labour.

Acknowledgements

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