Early Effect of the Suppression of the Smoking Habit on the Heart Rate Variability

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Abstract

Smoking habit induces alterations on cardiovascular parameters, but its suppression produces immediate effects on these parameters. This work studies the modification of the HRV parameters in habitual smokers during two 24-hour period. Fourteen habitual smokers were monitored in usual conditions (Group 1) and in the next 24 hours without smoking (Group 2). Diurnal and nocturnal periods were studied. In general, parameters decrease for Group 2, except in case of parasympathetic influence on heart rate variability, related with HF band, which is higher than Group 1 in both periods. The results obtained during the abstention show an increment of the vagal component in nocturnal period and a decrement in heart rate for both periods. Only time related parameters show significant differences between Group 1 and Group 2 in both nocturnal and diurnal periods. These results demonstrate the immediate recovering of cardiovascular parameters after smoking cessation.

1. Introduction

Smoking habit induce alterations on heart rate, heart rate variability (HRV) and other cardiovascular parameters, as blood pressure. However, its suppression produces immediate effects on these parameters. Their analysis one week after a non-smoking period showed that blood pressure and heart rate were significantly lower, and HF component were higher than the smoking period [1]. In a longer period (after a non-smoking year), mean heart rate was still in lower values than the smoking period [2].

But the main variation of this values seems to be concentrated in the initial non-smoking period, which may indicate an acute nature of the adaptation process. In fact, the results obtained in [2] showed that the main drop of the heart rate was found in the first day, and no significant variation was detected later in the rest of the analysed period. Another study [3] of the changes in blood pressure and heart rate after an overnight cessation and after one day of repeated smoking shows a increase in sympathetic activity to the vascular system in the morning, which is released by smoking the first cigarette.

The aim of this work is to study the modification of the HRV parameters in habitual smokers during two 24-hour period: the first one smoking and the second one of abstention.

2. Materials and methods

Fourteen healthy habitual smokers were monitored in usual conditions (Group 1) and in the next 24 hours without smoking (Group 2). 24-hours Holter electrocardiographic monitoring was used (Space Lab model 90205). The signal was digitized at a 250 Hz sampling frequency and 12 bit resolution. The signal processing was done with Matlab® v5.2. The RR series were obtained with a modification of the Pan and Tompkins algorithm [4].

Two time periods were studied: 1) diurnal (D: 11h-15h), and 2) nocturnal (N: 0-4h). The processing steps for the RR series of every period were the following [5]:

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

Results are given as mean ± SD. Statistical analysis of results has been done using Student's t-test for parameters

with normal distribution and Kolmogorov-Smirnov test for the others. Probability values $p<0.05$ have been considered statistically significant.

Variable	Description
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

Table 1. Frequency domain parameters analyzed.

Variable	Description
ANN	Average normal (NN) intervals over 5 minutes periods (ms)
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

Table 2. Time domain parameters analyzed.

3. Results

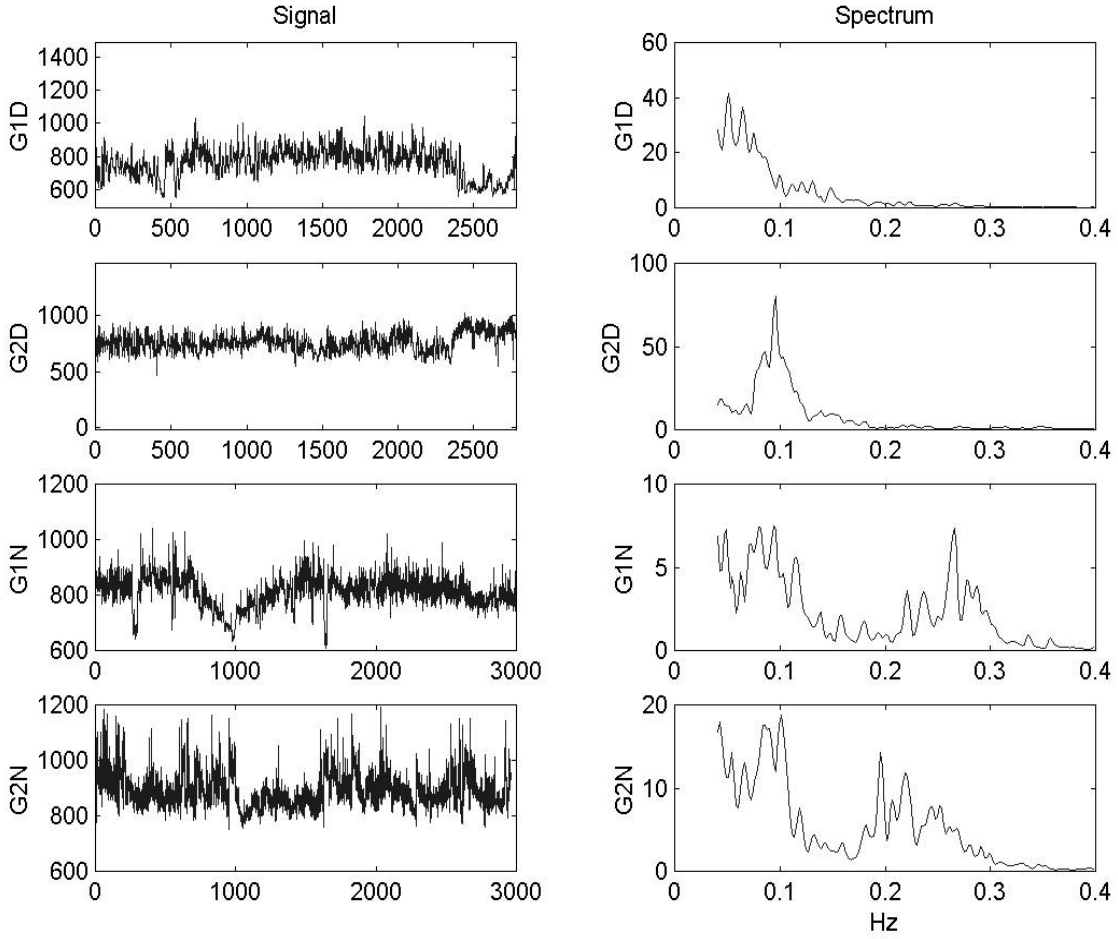

Figure 1. LF and HF bands spectra for Group 1 and Group 2, and the diurnal and nocturnal periods for the same patient.

Figure 1 shows an example of the spectra in LF and HF bands for group 1 (G1) and group 2 (G2) for diurnal (D) and nocturnal (N) periods. G2 exhibits a higher energy in HF for both periods.

Figures 2 and 3 show the average values obtained for the studied parameters of the two groups in function of the day/night period. In general, parameters decrease for G2, except in the case of parasympathetic influence on heart rate variability, related with HF band, which is higher than G1 in both periods.

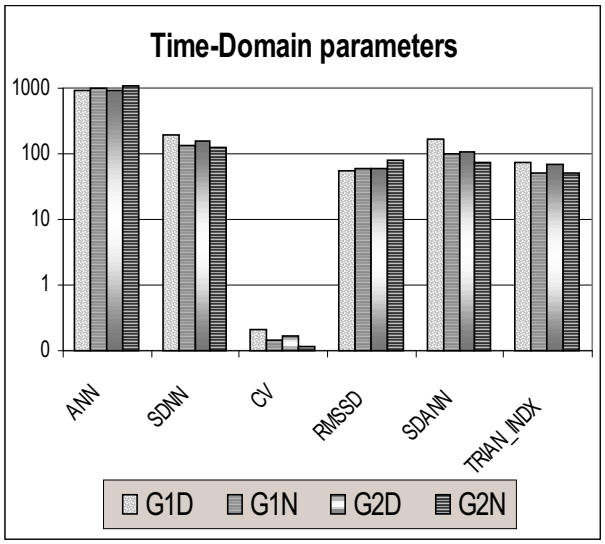

Figure 2. Mean values for time domain parameters.

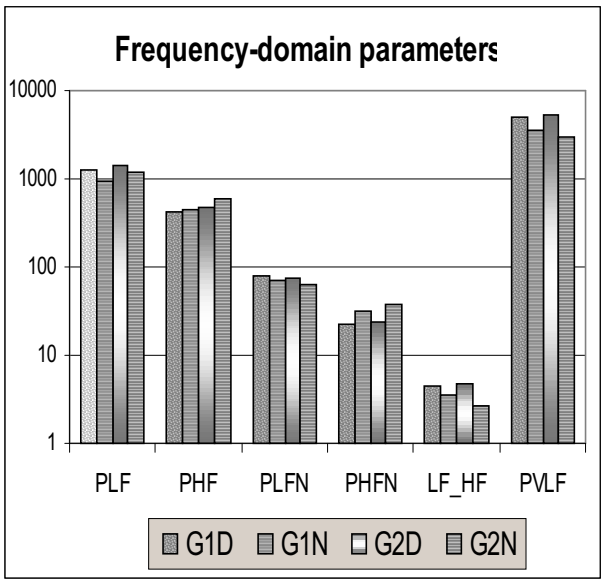

Figure 3. Mean values for frequency domain parameters.

Table 3 shows the values (mean ± SD, p) for the parameters showing significant differences between the two groups in the diurnal and nocturnal periods. In general, G1 shows a higher heart rate (lower NN period) than G2 (ANN: G1D: 929,78±104,66; G2D: 903,10±90,53, G1N: 964,94±124,12; G2N: 1107,90± 138,26 msec.), although only time parameters present significant differences between G1 and G2 in both nocturnal and diurnal periods.

Parameter	G1D	G2D	p
SDNN	191,01±57,90	151,36±38,11	*
CV	0,204±0,053	0,169±0,043	*
SDANN	166,68±71,60	110,27±42,78	*

Parameter	G1N	G2N	p
ANN	964,94± 124,12	1107,90± 138,26	**

Parameter	G1D	G1N	p
SDNN	191,01±57,90	138,77±65,94	*
CV	0,204±0,053	0,143±0,064	**
SDANN	166,68±71,60	100,43±73,64	*
TRIAN_ INDX	73,40±26,54	51,36±28,09	*
PLF	1241,60± 1027,68	946,37±671,18	*
PHFN	22,55±8,54	30,92±12,02	*

Parameter	G2D	G2N	p
ANN	903,10±90,53	1107,90±138,26	** *
SDNN	151,36±38,11	125,36±39,77	*
CV	0,169±0,043	0,114±0,035	** *
SDANN	110,27±42,78	71,73±52,56	*
TRIAN_ INDX	67,94±24,60	50,52±16,05	*
PLFN	76,50±8,49	63,07±10,59	**
PHFN	23,50±8,49	36,93±10,59	**
PVLF	5171,96± 3847,52	3067,88± 1249,22	*
LF/HF	4,71±2,49	2,69±1,21	**

Table 3. Results (mean±std, p) for the parameters that showing significant differences between groups and periods (*: $p<0.05$, **: $p<0.01$,***:$p<0.001$).

Comparisons between periods (D-N) for every group, show that G2 presents more parameters with differences, and the corresponding p exhibits lower values than G1, which implies an increment of the vagal component in nocturnal period during the abstention.

4. Conclusions

This work has studied the modification of the HRV parameters in habitual smokers during two 24-hour periods: the first one smoking and the second one of abstention.

The results obtained during the abstention show an increment of the vagal component in nocturnal period and a decrement in heart rate for both periods, although only time parameters show significant differences between G1 and G2 in both nocturnal and diurnal periods. A greater variability diurnal-nocturnal for abstention group was observed.

These results demonstrate the immediate recovering of cardiovascular parameters after smoking cessation.

Acknowledgements

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