Australasian Medical Journal AMJ 2010, 3, 11, 712-715

Assessing Autonomic Function in Smokers

Joshil Kumar Behera[1], Sushma Sood[1], Rajesh Gupta2,Naresh Kumar[1], Manjeet Singh[1], Anupama Gupta[1].

1.Department of Physiology,

2. Department of Chest & Tuberculosis, Post Graduate Institute of Medical Sciences,

Pt. B. D. Sharma University of Health Sciences, Rohtak, Haryana, India.

RESEARCH

Behera, J.K., Sood, S., Gupta, R. , Kumar, N. , Singh, M., Gupta, A. Assessing autonomic function in smokers. AMJ 2010, 3, 11, 712-715. Doi 10.4066/AMJ.2010.438

Corresponding Author:
Joshil Kumar Behera
Department of Physiology
PGIMS, ROHTAK, HARYANA
PIN 124001
MOBILE: 919812611899
Email: kumar.joshil6@gmail.com

Abstract

Background
Cigarette smoking is a major risk factor for the development of atherosclerosis, coronary heart disease, acute myocardial infarction, and sudden cardiac death. There is altered autonomic activity with increased adrenergic activity in chronic smoking which also predisposes to cardiovascular morbidity and mortality. To monitor the autonomic activity, Heart rate Variability (HRV) has emerged as efficient tool.

Method
A total of 60 subjects were included in the study out of which 30 were chronic smokers of at least 10 pack years and 30 were non smoker controls. The HRV was recorded in the supine subject in relaxed state. We recorded the frequency domain analysis [low frequency domain (LF), high frequency domain (HF) and LF/HF ratio] for which five minute recordings were taken and data was generated by the POLYRITE D system, supplied by RMS India P-Ltd. Chandigarh.

Results
Test group showed a significant (P<0.001) increase in heart rate with decreased RR interval as compared to control group. Also there was a significant (P<0.05) decrease in high frequency domain (HF) while there was a significant (P<0.05) increase in LF/HF ratio. There was a significant increase in heart rate (P<0.05) and LF/HF ratio (P<0.001) in the group with more than 15 pack years compared to less than 15 pack years, while there was a significant (P<0.05) decrease in RR interval, LF and HF values.

Conclusion
Smoking severely affects the cardiac autonomic functions which is evident with the study of heart rate variability, so the HRV should be included in routine investigations to access the severity of cardiac involvement in chronic smokers.

Key Words
Heart rate variability; parasympathetic; smoking; sympathetic.

Background

There are two major causes of preventable deaths one is smoking and the other is HIV.[1] In deaths due to smoking around 38% are attributed to TB, 31% from other respiratory causes, 33% from cancer and 20% from Heart Attacks or Stroke.[2] There is altered autonomic activity with increased adrenergic activity in chronic smoking which also predisposes to cardiovascular morbidity and mortality.[3-6] To monitor the autonomic activity, Heart rate variability (HRV) has emerged as efficient tool. HRV measures inter beat interval of consecutive heart beats and the oscillations between consecutive instantaneous heart rates and several physiological and pathological factors affect HRV.[7-19] Cigarette smoking is one of the major risk factors for the development of atherosclerosis, coronary heart disease, acute myocardial infarction, and sudden cardiac death.[20-22] Niedermaier et al reported that smoking acutely reduces baseline levels of vagal-cardiac nerve activity and completely resets vagally mediated arterial baroreceptor-cardiac reflex responses also, that Smoking reduces muscle sympathetic nerve activity and increases the sympathetic activity triggered by brief arterial pressure reductions.[23] Andrikopoulos et al reported that smoking causes an acute and constant decrease in vagal cardiac control.[24] In our study we compared the autonomic functions of chronic smokers with age and sex matched controls to evaluate the effect of chronic smoking on autonomic functions using heart rate variability.

Method

A total of 60 male subjects were included in the study and were drawn from staff members, attendants and patients of the tertiary hospital and medical college (Post Graduate Institute of Medical Sciences Rohtak, Haryana, India). They were divided into two groups. Test- 30 subjects chronic smokers Control-30 healthy non smokers. Test group was further divided into group A (n = 20) and group B (n = 10) depending on the duration of pack years (less or more than 15 pack years). The normal healthy subjects selected for the study had no history of smoking. Inclusion criteria of subject selection: Chronic smokers of at least 10 pack years. (1 pack year denoting a pack of cigarette i.e. 20 cigarettes smoked per day for a period of 1 year). Exclusion criteria of subject selection: History of any major illness in the previous 1 year (pulmonary disease, cardiovascular disorder, any endocrine or metabolic disorder, psychiatric disorder) or taking any drug for any ailments in last 1 month.

PROCEDURE FOR HEART RATE VARIABILITY

The procedure for performing HRV was explained to them in details. The basic anthropometric parameters such as age, height and weight were recorded. For HRV, POLYRITE D system, supplied by RMS India PVT. Ltd. Chandigarh was used. Sampling rate was 256 Hz. High and low filters were set at 99 and 0.1 Hzs respectively. The screen sweep speed was kept at 30 mm/sec. The HRV was recorded in the supine subject in relaxed state after attaching the electrodes- one each on left arm and right arm and one on the left foot. We recorded the frequency domain analysis for which five minute recordings were taken and data was generated by the machine. Frequency domain parameters (HF, LF and LF/HF) were noted. HF and LF were expressed in ms^2 while LF/HF is a ratio. Heart rate variability in control and test group was explained in method and material. Mean heart rate and RR interval was measured. Two spectral components were measured LF and HF and were expressed in ms^2. HF measures efferent vagal activity predominantly and LF measures both sympathetic and vagal influences. HF was measured in a range of 0.15-0.40 Hz and LF was measured in a range of 0.04-0.15 Hz and LF/HF ratio is an index of relative balance of sympatho-vagal influences on heart. Data were analyzed statistically by using the student's t-test.

Results

DEMOGRAPHIC PROFILES

Table 1: Comparison of demographic parameters among control and smokers

	Control Mean ±SD	Test Mean ±SD	P value
Age (years)	37.2±4.4	37.1±4.2	>0.05
Height (cm)	168±7.7	169.8±5.1	>0.05
Weight (kg)	62.6±7.6	61.9±7.8	>0.05
Body mass index (Kg /m^2)	22.2±2.8	21.5±3.1	>0.05

Table 1 shows that anthropometrically the groups were comparable.

Table 2 (page 715) shows that the mean heart rate in the group A was 84.6±7.78 bpm and the mean heart rate in the group B was 93.8±10.98 bpm. There was significant difference between both the groups and as compared to the test group. This showed that the test group has statistically very highly significant increased heart rate than Control group (p<0.001).

RR interval measured the time between successive R waves and the mean RR in the group A was 0.71±0.06 seconds and the mean RR in group B was 0.64±0.07 seconds. There was statistically significant difference between both the groups. Statistically significant difference was also seen when group A and B were compared with control group. Mean RR interval in the control group was 0.83±0.06 seconds with a range between 0.72-0.94 seconds and the mean RR in the test group was 0.69±0.07 seconds with a range between 0.50-0.89 seconds. The test group and control group difference was statistically very highly significant (p<0.001).

Also the mean LF in group A was 378.55±383.04 ms^2 and the mean LF in group B was 127.1±82.54 ms^2. The difference between the groups was statistically significant (p<0.05). The mean HF in the group A was 112.75±85.39 ms^2 and the mean HF in the group B was 32.4±24.76 ms^2. The value of group was statistically significant. Also there was a significant decrease in LF and HF in group B as compared to the control group. This table also shows that the mean HF in the Control group was 127.50±84.09 ms^2 with a range between 5-344 ms^2 and the mean HF in the test group was 85.96±80.32 ms^2 with a range between 4-295 ms^2. This shows that the value of test group was significantly less than the control group.

The mean LF/HF in the group A was 3.70±1.34 and the mean LF/HF in the group B was 6.36±3.72. This shows that there was a statistically significant (p<0.001) difference between group A and B. The difference between the group A and Control was not significant while that between group B and Control was significant. The above table also shows that the mean LF/HF in the Control group was 3.05±2.39 with a range between 1.37-14.73 and the mean LF/HF in the test group was 4.59±2.67 with a range between 2.03 to 14.42. Statistically significant increase was observed in LF/HF of the test group.

The mean LF/HF in the group A was 3.70±1.34 and the mean LF/HF in the group B was 6.36±3.72. This shows that there was a statistically significant ($p<0.001$) difference between group A and B.T he difference between the group A and Control was not significant while that between group B and Control was significant. Table 2 also shows that the mean LF/HF in the Control group was 3.05±2.39 with a range between 1.37-14.73 and the mean LF/HF in the test group was 4.59±2.67 with a range between 2.03 to 14.42. Statistically significant increase was observed in LF/HF of the test group.

Discussion

In our study there was a statistically significant increase in heart rate and decrease in RR interval among smokers than non smokers ($p<0.001$)**.** Further there was a significant increase in heart rate and decrease in RR interval in smokers with more than 15 pack years as compared to those with less than 15 pack years. Hirsch et al also observed a significant increase in mean heart rate in smokers compared to non smokers which may be due to decreased vagal tone.[25]

The LF power spectrum is evaluated in the range from 0.04 to 0.15 Hz. LF is thought to represent both sympathetic and parasympathetic activity. In our study there was no significant difference in LF of test and control groups. While based on packed years it was seen that there was a significant ($p<0.05$) decrease in LF of the group B (more than 15 pack years) compared to the control. Lucini et al found significantly reduced LF in smokers compared to non smokers.[26] while, Karakaya et al observed a significant increase in LF on acute smoking.[27]

The HF power spectrum is evaluated in the range from 0.15 to 0.4 Hz. This band reflects parasympathetic (vagal) tone and fluctuations caused by spontaneous respiration known as respiratory sinus arrhythmia. In our study there was a significant ($p<0.05$) decrease in HF of the test group compared to the controls. Although the group A (less than 15 pack years) showed no significant difference with control, but the group B (more than 15 pack years) showed a significant ($p<0.05$) decrease in HF as compared to group A as well as control. Similarly lucini et al showed significantly reduced HF in smokers compared to non smokers.[26] contrary to this Karakaya et al observed a significant increase in HF on acute smoking.[27]

The LF/HF Ratio is used to indicate balance between sympathetic and parasympathetic tone. A decrease in this score might indicate either increase in parasympathetic or decrease in sympathetic tone. It is considered together with absolute values of both LF and HF to determine what factor contributes in autonomic disbalance. In our study there was a significant increase in LF/HF ratio in smokers as compared to non smokers. Group B (more than 15 pack years) showed a significant increase in LF/HF ratio as compared to group A (less than 15 pack years) as well as control group. Similarly Lucini et al found significantly increased LF/HF ratio in smokers compared to non-smokers.[26] but in a study by Karakaya et al there was a significant decrease in LF/HF ratio on acute smoking.[27] Also, Esen et al showed a significant increase in LF/HF ratio on change of posture from supine to erect in non smokers as compared to smokers.[28] In our study the subgroups A and B were actually taken from the test group to show the effect of number of pack years, so the sample size was small.

Conclusion

Smoking causes altered autonomic functions also there is much more damage to autonomic system as the duration of smoking increases, so heart rate variability should be assesssed in patients who smoke for early diagnosis of heart diseases.

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PEER REVIEW

Not commissioned. Externally peer reviewed.

CONFLICTS OF INTEREST

None

Table 2: Comparison of mean heart rates and RR interval and frequency domain parameter of HRV between test , control groups and groups according to the number of pack years

	Group A (<15 pack years) n= 20	Group B (>15 pack years) n= 10	Test group (A + B) n=30	CONTROL n=30
Heart rate(bpm)	**84.6±7.78****	**93.8±10.98**¥**	**87.66±9.83****	**72.46±6.02**
RR interval (seconds)	**0.71±0.06****	**0.64±0.07** ¥**	**0.69±0.07****	**0.83±0.06**
LF (ms^2)	**378.55±383.04**	**127.1±82.54*¥**	**294.73±335.82¥**	**297.33±246.71**
HF (ms^2)	**112.75±85.39**	**32.4±24.76*¥**	**85.96±80.32***	**127.50±84.09**
LF/HF	**3.70±1.34**	**6.36±3.72*¥¥**	**4.59±2.67***	**3.05±2.39**

* - Comparison with control (*P<0.05, **P<0.001)
¥- Comparison with group A (¥P<0.05, ¥¥P<0.001)
¥- Standard deviation is greater than mean as the data was skewed