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Original Article

Correlation between Heart Rate Variability and Pulmonary Function Tests in Tobacco Chewers

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Abstract

Introduction: Tobacco chewing is more prevalent than smoking in India. It causes local lesion such as lichenoid lesions, leukoplakia, and erythroplakia and various cancers of oral cavity, pharynx, larynx, etc. It also adversely affects cardiorespiratory parameters. Studies have shown adverse effects of tobacco chewing and smoking on ventilatory function tests parameters and heart rate variability (HRV). However, there is a paucity of literature on correlation between HRV and pulmonary function test in tobacco chewers. Hence, this study is planned.

Material and Methods: A total of 60 male subjects in the age group of 25–50 years – 30 tobacco chewers and 30 tobacco non-users were included in the study. Subjects with a history of hypertension, diabetes, oral lesion, drug intake, etc., were excluded from the study. Ventilatory function tests were carried out using RMS Med spirometer. HRV was performed by Polyrite 26D.

Results: A negative correlation between FEV_1 and mean HR was seen. There was a positive correlation between FEV_1 and mean RR interval and FEV_1 and LF. The value of correlation coefficient in these parameters was statistically significant. There was a significant negative correlation between FVC and LF.

Conclusion: Correlation exists between few parameters HRV and ventilatory function tests.

Key words: Chewers, Correlation, Heart rate variability, Tobacco, Ventilatory

INTRODUCTION

Tobacco chewing is presumed as non-injurious and considered as an alternative to smoking. However, tobacco chewing has its own health hazards. It is one of the most important risk factors for the development of oral mucosal lesions including various oral pre-cancerous lesions like lichen planus, lichenoid lesions, leukoplakia and erythroplakia. Harmful effects of chewing tobacco on cardiorespiratory system are seldom known. Nicotine present in tobacco is an addictive and cardioactive agent.[1,2] Various studies have shown adverse effects of tobacco chewing and smoking on ventilatory function tests parameters.[3-5] Effect of smokeless tobacco on heart rate variability (HRV) has also been demonstrated. However, there is a paucity of literature on correlation between HRV and pulmonary function test in tobacco chewers.[6-8] Hence, this study was carried.

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MATERIALS AND METHODS

The present study was conducted in the Department of Physiology, Pt. B.D. Sharma PGIMS, Rohtak. A total of 90 male subjects of age group 25–50 years were included in the study. The subjects were divided into three groups. Study was carried out after ethical approval from the Institutional Ethical Committee. Informed consent was obtained from the subjects before proceeding with the procedure. Information was provided in the language familiar to the subjects.

- Group I – 30 male volunteers who were chronic tobacco chewers (non-smokers) for minimum 10 pouch years in continuation with duration of 7 years or more.

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- Group II – 30 male volunteers who had never used tobacco in any form (control group).

Subjects with known history or symptoms of any chronic cardiopulmonary, endocrine, or metabolic disorder, oral lesion, and any drug intake were excluded from the study.

Tests Conducted

1. Ventilatory function tests
2. HRV.

Procedure for Recording Ventilatory Functions

The ventilatory functions were recorded using the RMS Med spirometer. The Med spirometer is an instrument which measures inspiratory and expiratory parameters. The test progress is shown on the computer monitor. The subjects were instructed to apply mouth piece closely to the lips and close their nose with nose clip so as to prevent any leakage of air. Following parameters were recorded:

- Forced expiratory volume in first second (FEV_1)
- Forced vital capacity (FVC)
- FEV_1/FVC%
- Forced expiratory flow rate $_{25-75\%}$ ($FEF_{25-75\%}$)
- Maximum voluntary ventilation (MVV)
- Peak expiratory flow rate (PEFR).

Procedure for Recording FEV_1, FVC, $MEFR_{25-75\%}$, and PEFR

For recording of FVC, FEV_1, $MEFR_{25-75\%}$, and PEFR, the subjects were asked to breathe in and out normally into the mouth piece. Then, the subjects were asked to take deep breath to fill lungs to maximum possible and then exhale into the mouth piece as quickly as possible. All the subjects made three such attempts and the best of them was selected.

Procedure for Recording MVV

For recording of MVV, subjects were asked to inhale and exhale as deeply and quickly for 15 s. Then, MVV was calculated in liters/minute. The subjects were instructed to stop if they felt any discomfort.

Spirometric indices were calculated using best out of three technically satisfactory performances as per recommendations of the American Thoracic Society.[9]

Procedure for Recording HRV

For recording HRV, Digitalized PowerLab 26T Polyrite D was used. Sampling rate was 256 Hz. High and low filters were set at 99 and 0.1 Hz, respectively. The screen sweep speed was kept at 30 mm/s. For R wave detector, channel 3, that is, ECG channel 3 was used. The whole channel was selected for HRV analysis. Position of event is taken as maximum after threshold. Retrigger delay is taken as 0. Ectopics are excluded from the analysis.

Method of Measurement

HRV of subjects was measured with digitalized Polyrite D as per standards laid by Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology.[10]

Procedure

The subjects were asked to lie down on the couch and made to relax in front of the Polyrite D system. The three disposable adhesive electrodes were attached to left arm, right leg, and left leg, respectively. The basal recording of ECG (Lead II) was taken for 5 min. From the ECG, the analysis of HRV was done automatically by fast Fourier transformation method.

Outcome of Variables

HRV parameters generated and selected for study.

- Mean heart rate (beats/min)
- Mean RR interval (seconds)
- VLF (ms^2)
- LF (nu)
- HF (nu)
- LF/HF ratio.

Statistical Analysis

All the data obtained by above two procedures were analyzed by a commercially available software package SPSS software. Statistical significance between Group I and Group II was determined using Student's unpaired *t*-test. Pearson's correlation coefficient was used for correlation purpose. $P < 0.05$ was considered statistically significant and $P < 0.001$ was considered highly significant.

RESULTS

Since both the groups were comparable, there was no significant change in terms of anthropometric variations.

All the ventilatory parameters were reduced in Group I and the reduction was significant except for FEV_1/FVC ratio [Table 1]. There was a significant reduction in values of VLF, LF, and HF and a significant increase in LF/HF ratio [Table 2].

There is negative correlation between FEV_1 and mean HR. There is positive correlation between FEV_1 and mean RR interval and FEV_1 and LF. The value of correlation coefficient in these parameters is statistically significant. There is negative correlation between FVC and mean HR. There is very strong negative correlation between FVC and LF [Figure 1]. The value of correlation coefficient in these parameters is statistically significant. There is a significant negative correlation between $FEF_{25-75\%}$ and

Table 1: Ventilatory function tests in Group I and Group II

Parameters	Group I (chewers) (*n*=30) (Mean±SD#)	Group II (control) (*n*=30) (Mean±SD)	*P* value
FEV_1 (L)	1.73± 0.58	2.87± 0.41	0.001*
FVC (L)	1.90± 0.51	3.17± 0.52	0.001*
FEV_1/FVC (%)	90.2±11.4	96.24±11.0	0.84
$FEF_{25-75\%}$ (L/s)	2.31±1.47	3.96±1.06	<0.001**
MVV (L/m)	74.4±30.7	125.9±25.7	<0.001**
PEFR (L/min)	3.53±1.82	7.05±1.98	<0.001**

*P<0.05: Significant, **P<0.001: Highly significant, #SD: Standard deviation. FEV_1: Forced expiratory volume in first second, FVC: Forced vital capacity, $FEF_{25-75\%}$: Forced expiratory flow rate $_{25-75\%}$, MVV: Maximum voluntary ventilation, PEFR: Peak expiratory flow rate

Table 2: Comparison of HRV parameters in Group I and Group II

Parameters	Group I (chewers) (*n*=30) (Mean±SD#)	Group II (control) (*n*=30) (Mean±SD)	*P* value
HR (beats/minute)	80.21±9.56	73.94±15.0	0.059
RR interval (seconds)	744.19±150.66	760.09±93.38	0.628
VLF (ms^2)	501.58±416.83	1977.13±1104.22	0.0001**
LF (nu)	53.72±10.95	59.91±12.87	0.048*
HF (nu)	22.94±6.39	47.07±63.16	0.0001**
LF/HF	2.52±0.91	2.02±0.92	0.035*

*P<0.05: Significant, **P<0.001: Highly significant, #SD: Standard deviation. HRV: Heart rate variability

Table 3: Pearson's correlation between ventilatory function tests and HRV parameters in Group I

Variables	Mean HR	Mean RR	VLF (ms^2)	LF (ms^2)	HF (ms^2)	LF/HF
FEV_1	−0.405*	0.367*	0.058	0.368*	0.078	0.271
FVC	−0.389*	0.273	0.089	−0.68**	0.059	0.281
FEV_1/FVC	−0.130	0.246	0.137	0.039	0.082	−0.217
$FEF_{25-75\%}$	−0.378*	0.403*	0.152	0.298	0.239	0.050
MVV	−0.282	0.282	−0.091	0.252	0.029	0.167
PEFR	−0.344*	0.423*	0.161	0.236	0.156	0.159

*P<0.05: Significant. FEV_1: Forced expiratory volume in first second, FVC: Forced vital capacity, $FEF_{25-75\%}$: Forced expiratory flow rate $_{25-75\%}$, MVV: Maximum voluntary ventilation, PEFR: Peak expiratory flow rate, HRV: Heart rate variability

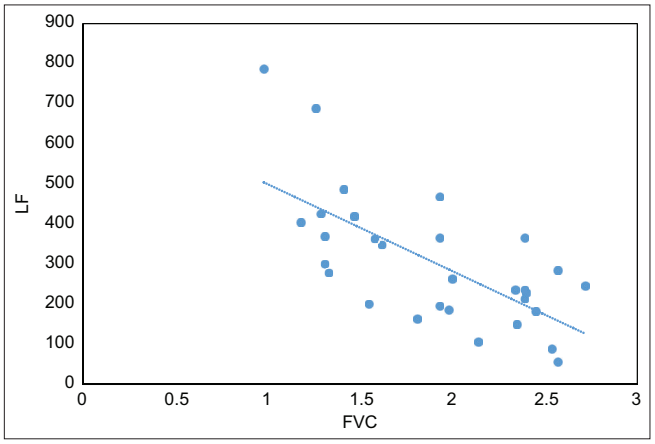

Figure 1: Correlation between LF and FVC in Group I

mean HR, and between PEFR and mean HR. There is a significant positive correlation between $FEF_{25-75\%}$ and mean RR interval and between PEFR and mean RR interval. Correlation coefficient among other parameters is very weak and statistically insignificant [Table 3].

DISCUSSION

Prevalence of smokeless tobacco use is 26% which is far greater than smoking (14%) among adults as reported by Global Adult Tobacco Survey report of India.[11] In our study, all the ventilatory function parameters were significantly reduced in Group I. This was also reported by Pramanik *et al.*[5] Smokeless tobacco products induce oxidative stress resulting from imbalance between formation of reactive oxygen species and antioxidants, contribute to chronic airway limitation.[12] These free radicles alter the cellular antioxidant defense system. Lam *et al.* have demonstrated the release of free radicle nitric oxide from extracts and components of smokeless tobacco in human saliva of SLT users.[13] Some other workers have, however, reported oxygen free radical (O2–) production in cells exposed to smokeless tobacco and nicotine.[13-15] In an animal study, it was demonstrated that long-term (2 weeks) administration of aqueous extracts of gutkha (a type of SLT) rats, impaired the enzymatic antioxidant defense system, and reduces glutathione levels in liver, lung, and kidney, leading to inflammatory changes in these organs.[16]

All the HRV frequency domain parameters except for LF/HF were reduced in Group I, indicating sympathovagal imbalance suggestive of increased vagal tone. Chewing of tobacco results in considerable systemic exposure to nicotine.[17] The predominant cardiovascular effects of nicotine result from activation of the sympathetic nervous system. The state of sympathovagal balance is used for the prediction of many cardiovascular dysfunctions.[14] Studies in both SLT users and smokers have shown cardiac sympathovagal imbalance.[15,16-21] Nicotine increases the cardiac output by increasing both the heart rate and the myocardial contractility.[22]

CONCLUSION

Tobacco chewing affects both HRV and ventilatory function parameters indicating its detrimental effect on both cardiac and respiratory systems. Pulmonary function tests and HRV can be considered as diagnostic tool for preclinical assessment of cardiorespiratory status.

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