Original Article

Evaluation of the Cardiovascular Risk by Early ECG Changes in Smokers – A Cross Sectional Study

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Abstract

Background: Smoking is a major risk factor for coronary artery disease. Nicotine, an important component of cigarette smoke is known to cause electrophysiological changes on the ECG which if identified early can contribute to prevention of Coronary artery disease. Objective: To evaluate the association of ECG changes in smokers compared with non -smokers. **Subjects and Methods:** A cross sectional study was undertaken in a Government Medical College in Chennai comprising of 150 healthy male smokers (with no known pre-existing disease) divided into three groups based on pack years of smoking and a fourth group of 50 healthy male non-smokers that served as the control group. A resting 12 lead ECG was taken for all the study participants and the ECG parameters were analysed. Simple descriptive statistics, Chi-square test and student's independent t-test were employed for statistical analysis of the data. **Results:** ECG abnormalities were found to be more prevalent in smokers (23.33%) than in non smokers (10%) The ECG changes observed were an increased heart rate, increased QTc interval, increased P wave amplitude and decreased S-T segment duration even in apparently young healthy smokers. A statistically significant association was also seen between the prevalence of ECG changes and pack years of 5 or more. **Conclusion:** Electrophysiological changes develop even in healthy smokers, increasing with higher pack years of smoking. The ECG is a simple, cost effective tool that can be used to motivate smoking cessation and early intervention to reduce cardiovascular morbidity and mortality.

Keywords: Cardiovascular risk, smoking, ECG changes.

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Introduction

Smoking is one of the major modifiable risk factors for Coronary Artery Disease worldwide and it is just one of the forms in which tobacco is consumed. Significant morbidity and mortality is associated with tobacco consumption. Nearly 2.6 million deaths occur every year in India due to coronary heart disease, which constitutes 54.1% of all cardiovascular disease. It is estimated that by the year 2030, 80% deaths may be related to tobacco consumption.[1]

The major component of tobacco is nicotine which produces sudden cardiac death often due to ventricular arrhythmias. These cardiac effects of tobacco are due to the release of catecholamines, caused by binding of nicotine to the cholinergic gate of cationic channels in the receptors all over the body. Nicotine further inhibits cardiac A type of Potassium channels, which induces arrhythmias and electrophysiological changes. These electrophysiological changes produced by cigarette smoking can be picked up very early by doing an ECG.[2] This early detection may help in motivating smoking cessation and also possible therapeutic intervention where necessary. This would pave the way for an eventual decrease in cardiovascular morbidity and mortality.

This study is therefore aimed at detecting these early electrophysiological changes induced in healthy smokers by comparing the ECG findings in matching non smokers and also to document whether these ECG changes correlated with the number of pack-years defined as the number of cigarette packs smoked per day multiplied by the number of years of smoking. This would also throw light about the correlation between the quantum of smoking as indicated by the pack years and the extent of ECG changes.

Subjects and Methods

A cross sectional study was conducted in a Government Medical College, Chennai for a period of six months from January 2018 to June 2018. The study sample consisted of 200 healthy male subjects in the age group of 25- 40 years, who attended the out patients clinics for routine checkup in the Department of General medicine. The study group included 150 young healthy male smokers and 50 non-smokers. A detailed proforma was used for each patient,that included the number of pack years for each subject.

Inclusion criteria:
Young healthy male – smokers & nonsmokers between the age of 25-40 years of age

Exclusion criteria:
All subjects with preexisting conditions as listed below

were excluded from the study since these could possibly confound the ECG changes.

- Hypertension
- Diabetes
- Dyslipidemia
- Coronary artery disease
- Chronic Obstructive Pulmonary Disease
- Chronic kidney disease
- Alcohol abuse
- Anxiety and depressive disorder,
- Female gender

The Institutional Ethical Committee clearance was obtained and subjects were recruited into the study after receiving their informed written consent. The study subjects were divided into two groups. Group A consisted of 50 young healthy non-smokers and Group B consisted of 150 young healthy smokers. The Group B subjects were further subdivided in to 3 categories on the basis of the pack-years as follows.

a) Light smokers   : 1-5 pack-years
b) Moderate smokers   : 6-10 pack-years
c) Heavy smokers   : 11-15 pack-years

Detailed history and clinical examination was done for all the subjects. A 12 lead Electrocardiogram was taken in resting supine position for all the subjects. The following ECG parameters were assessed viz., heart rate, P wave amplitude, P wave duration, P-R interval, QRS duration, R-R interval, QTc interval and ST segment duration.

The results were analyzed statistically using SPSS software version 16.0 (Chicago, SPSS Inc). . Simple descriptive statistics were used to describe the distribution of the data obtained. Chi-square test and student's independent t-test were employed for statistical analysis of the data. A p-value of <0.001 was taken as highly significant, p-value of < 0.05 as significant and p- value > 0.05 as non-significant.

Results

The total number of participants in our study was 200 males, among which 50 were non-smokers and 150 were smokers. Demographic analysis showed that the mean age of smokers was 32.54 (SD 3.83) while that of the non-smokers was 32.36 (SD 4.12). Majority of the participants, 77 (38.5%) belonged to the age group of 31-35 years, while 35.5% and 26% of them belonged to the age groups 25-30 years and 36-40 years, respectively. With regards to the pack years, 34.5% of the participants had smoked for 1-5 pack -years, 28% had smoked 6-10 pack years and 12.5% had smoked for 11-15 pack-years

Prevalence of ECG abnormalities:

35 out of 150 smokers and 7 out of 50 non-smokers exhibited ECG abnormalities (chart 1). The prevalence of ECG abnormalities among the smokers in our study was thus 23.33% and among the non-smokers was 10%. On applying chi-square test, there was a statistically significant association between the smoking status and ECG abnormalities (p=0.041) As the next step in the statistical analysis, 'Independent t test' was applied to find the

difference in the ECG parameters between the various groups.

Comparison of ECG parameters between Smokers and Non-smokers

Various ECG parameters were compared between non-smokers and smokers (chart 2). It was observed that the mean heart rate was 77.38 ± 8.34 and 84.65± 12.30 in non-smokers and smokers respectively. The Heart rate was thus significantly increased in smokers compared to non-smokers (p< 0.001).The P wave amplitude was 0.1165 ±0.172 and 0.1290± 0.247 in non- smokers and smokers respectively. The P wave amplitude was significantly increased in smokers compared to non- smokers (p-value - 0.001).The QTc interval was 361.66±7.58 and 377.21±24.13 in non - smokers and smokers respectively. The QTc interval was significantly increased in smokers compared to non -smokers (p<0.001). ST segment interval was 114.40±7.60 and 110.07±13.03 in non-smokers and smokers respectively. The ST segment duration was significantly decreased in smokers compared to non-smokers (p 0.002).However the other ECG parameters like P wave duration, PR – interval, QRS duration and RR interval, were not significantly different between the non-smokers and smokers, in our study.

Relationship between ECG parameters and pack years

The ECG changes in non- smokers and smokers (divided into three groups of 1-5,6-10,11-15 pack years) were compared and analysed for statistically significant differences in ECG parameters (Table 1). Amongst the various ECG parameters, we observed that the mean heart rate was 77.38±8.34 in non-smokers and 79.45±6.57, 85.94±11.79 and 89.89± 16 .05 in smokers (divided into 1-5, 6-10 and 11- 15 pack years group) respectively. Heart rate increased as the pack years of smoking increases, and this was statistically significant (p<0.001) in the 11-15 pack years group as compared with non – smokers and other pack years group smokers.

The QTc interval was 361.66±7.58 in non-smokers and 364.81±12.24, 380.32±23.28 and 404.48±26.64 in smokers (divided into 1-5, 6-10 and 11- 15 pack years group) respectively. The QTc interval increased as the pack years of smoking increases, and this rise was significantly high (p < 0.001)) in 11- 15 pack years group as compared with non-smokers and other pack years group smokers.

P wave amplitude was 0.1165±0.17 in smokers and 0.1192 ± 0.19, 0.1308±0.02 and 0.1500 ± 0.22 in smokers (divided into 1-5, 6-10 and 11- 15 pack years group) respectively. The P wave amplitude increased as the pack years of smoking increases, and this rise was significantly high (p<0.001) in the 11- 15 pack years group as compared with non-smokers and other pack years group smokers.

ST segment was 114.40±9.93 in non-smokers and 110.43±14.08, 107.32 ±13.41, 115.20 ±5.85 in smokers (divided into 1-5, 6-10 and 11- 15 pack years group) respectively. ST segment significantly decreased in 6-10 pack years group as compared with non – smokers and other pack years group smokers. The Other ECG parameters did not have significant difference between non- smokers and various pack years group of smokers.

Table 1: Comparison between ECG changes in Non-smokers vs the 3 groups of Smokers

| ECG parameter	Non smokers Mean (SD) n=50 A	Smokers 1-5 pack years Mean (SD) n=69 B1	Smokers 6-10 pack years Mean (SD) n=56 B2	Smokers 11-15 pack years Mean (SD) n=25 B3	p value A-B1	p value A-B2	p value A-B3
Heart rate (beats/min)	77.38 (8.34)	79.29 (6.796)	86.11 (12.898)	96.20 (13.991)	0.172	<0.001	< 0.001
p wave amplitude (mv)	0.1165 (.0172)	.11920 (.019243)	.13080 (.024768)	.15200 (.022730)	0.431	0.001	< 0.001
p wave duration (ms)	85.40 (6.13)	86.81 (6.300)	85.00 (5.721)	84.80 (5.859)	0.225	0.729	0.686
PR interval (ms)	131.80 (8.00)	130.87 (7.619)	132.50 (6.941)	132.80 (6.782)	0.521	0.631	0.594
QRS duration (ms)	86.40 (6.92)	85.94 (5.770)	85.00 (6.030)	86.00 (5.774)	0.695	0.269	0.804
RR interval (ms)	73.40 (6.26)	74.93 (6.779)	74.29 (6.283)	73.60 (6.377)	0.213	0.470	0.897
QTc interval (ms)	361.66 (7.58)	364.81 (12.241)	380.32 (23.282)	404.48 (26.648)	0.110	< 0.001	< 0.001
ST segment(ms)	114.40 (7.60)	110.43 (14.083)	107.32 (13.415)	115.20 (5.859)	0.091	0.003	0.712
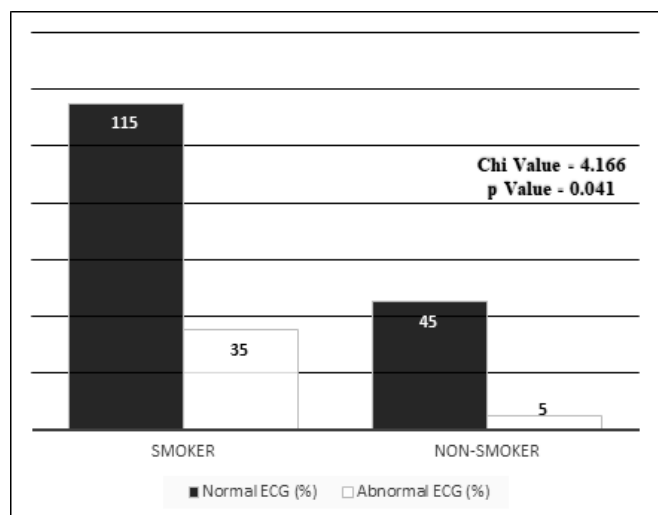
Figure 1: Association between ECG abnormalities and smoking status (N=200)
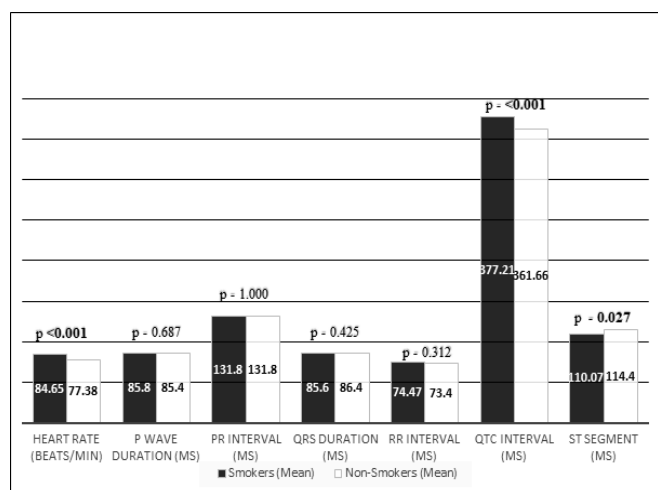

Figure 2: Comparison of ECG parameters between Smokers and Non-smokers (N=200)

Discussion

ECG abnormalities were found to be more prevalent in smokers (23.33%) then in non-smokers (10%) in our cross sectional study. Nirmal kumar sharma et al in their study have reported that the prevalence of ECG abnormalities in smokers was 56.66% compared to non –smokers 6%. (p <0.001).[3] Resting heart rate is found to be increased in smokers in this study. This is due to high sympathetic tone, stimulation of sympathetic ganglia and release of catecholamines from adrenal medulla. This finding is consistent with the findings of other studies which state that the Heart Rates were 72.74, 90.98 and 93.87 in non-smokers, male smokers and female smokers respectively.[3] Swathi k et al also noted that heart rate was increased in smokers (80.28) compared with non-smokers (74.86).[4]

P wave amplitude increased in smokers proportionate to the number of pack years of smoking. Further the 'P' wave amplitude showed significant increase as compared to non-smokers in this study. This is probably due to decreased right ventricular compliance which in turnin turn leads to right ventricular hypertrophy. This is consistent with the results of other studies.[4]

The QTc interval is yet another ECG parameter that increased significantly in smokers compared to non-smokers in this study and more so with increasing number of pack years. This increased QTc interval in smokers is due to altered ventricular repolarization which varies between smokers and non-smokers due to variation in heart rate. Deokar et al, did a study on QTc prolongation in healthy smokers and observed that QTc interval was higher in smokers (0.38sec) than non-smokers (0.37 sec) [p –value <0.007].[5] A contrary opinion has been documented by Thangarasa A et al,[6] who noted that QTc interval was 0.42 amongst smokers and 0.43 in non-smokers (p- value 0.121). Shyamala devi et al,[7] observed that QTc interval was minimally increased in smokers (0.36sec) as compared to non-smokers (0.32 sec) [p-value -0.1187], although not statistically significant. In a study conducted by Renuka Devi et al, it was found that QTc interval was shortened and QRS complex duration was widened in the smokers, although there was no statistically significant difference between smokers and non smokers.[8]

The duration of the ST segment declined in smokers as compared to non-smokers. This decreased ST segment duration is due to shortened ventricular repolarization. Due

to shortened ventricular repolarization during diastole, cardiac perfusion is also reduced which in turn leads to cardiac ischemia. Sandhya M et al,[9] in her study recorded the ECG changes and left ventricular diastolic dysfunction as hemodynamic markers of myocardial stress in patients who are smoking. Her result revealed that ST segment duration shortened in smokers which was statistically significant (P< 0.001). Siddiqui S et al,[10] in their study also observed that ST segment duration was 0.115 in smokers and 0.122 in non-smokers, but the result was not statistically significant.

The QRS duration in this study showed no significant changes, but shortening of QRS duration has been reported by Venkatesh G et al,[11] Salman S Siddiqui et al,[10] Metta sandhya et al.[9] Smoking of even a single cigarette in both smokers and non-smokers can lead to a rise in QTd.[12] Some studies show that chronic cigarette smoking is associated with a prolonged Tp-e interval, increased Tp-e/QT ratio and Tp-e/QTc ratio indicating that there may be a relationship between smoking and altered ventricular repolarization.[13] ECG is thus a non-invasive and cost effective method for cardiovascular risk assessment in smokers Other ECG parameters like P wave duration,[14,15] P-R interval, QRS duration, R-R interval showed no significant changes in both the study groups in our study.

Conclusion

In conclusion it may be stated that smoking induces significant alterations in cardiac electrophysiology. Increased heart rate, Increased QTc interval, Increased P wave amplitude and decreased S-T segment duration were found in apparently young healthy smokers which predisposes to increased cardiovascular morbidity and mortality.

The prevalence of ECG abnormalities is certainly more common in smokers, compared to non-smokers. Therefore the ECG can be used as a simple and cost effective tool to assess the early cardiovascular changes induced by smoking.

Since smoking is an important modifiable risk factor in cardiovascular diseases, early intervention, health education and promoting smoking cessation will eventually decrease the incidence of the cardiovascular disorders.

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