Analyses of Changes in Electrocardiogram Signals during Hookah Smoking

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Abstract— **Hookah Smoking results to escalation in premature beats of the ventricles, which tend to be a leading risk factor that results to sudden cardiac death (SCA). Hookah smokers tend to be at high risk for cardiovascular diseases due to tobacco consumption from a hookah device. The primary objective of this research is to analyze immediate consequences of hookah smoking on ECG. A secondary aim is to compare changes that occur in ECG before and after hookah smoking. ECG changes powerfully predict future cardiovascular disorders (CVD) events. Twenty Male volunteers who are sound in health and are in the age bracket of 18-30 years were recruited for the study. The ECG of the subjects was recorded using a 3- lead electrocardiogram. From the lead to, PR interval, QRS (amplitude) and RR interval were recorded and heart rate was also determined, (P, Q, R and S are ECG signal's parts). Various changes observed in this study were results of persistent and terrible consequences of hookah smoking that may result into chronic CVD. These abnormalities could be identified with the help of a simple noninvasive tool by determining the wave amplitude and duration of ECG parameters.**

Keywords — Electrocardiogram, Hookah, Smoking, Cardiovascular, Noninvasive.

I.   INTRODUCTION

Statistics has shown that mortality rate as increased above 5 million annually due to increase in tobacco use, and with the increase in the consumption the death rate might rise above 10 million within a term of 2 to 3 decades [1]. Besides, many researches focus on different practices in consuming tobacco such as cigarettes, while little researches were done in the method, such as the hookah smoking. This was outlined at the twelfth World Tobacco or health conference held in 2003, where shortfall of hookah research was identified by delegates, even though hookah is being consumed by hundreds of million users around the world daily [2].

Hookah (sometimes called narghile or shisha) is a system of smoking that involves the usage of water pipe in smoking tobacco. Smoking of hookah is a conventional mode of tobacco consumption that was originated from eastern Mediterranean region for more than 400 years [3].

Smoking hookah has become a reactional activity among teenagers and young adults around the world [3]. The tobacco is indirectly heated by a hookah device. The smoke produced then travels via a column filled with water and afterward the smoke is being inhaled by the use of a water pipe, and the inhalation is done via the mouth [4]. The smoke from a hookah has dangerous chemical contents at high degree, some of the content includes; nicotine, carbon monoxide (CO), tar and cancer cells (carcinogens) [5]. Carcinogens and other dangerous gases like CO, are substances which hookah smokers are always exposed to whenever they consume the substance. It was reported that hookah smokers have markedly higher concentration of CO in circulation, against the CO in the blood of cigarettes smokers [6]. According to Uyanık et al, [7] Research as shown that consumption or smoking of a complete packet of cigarettes is parallel to one-hour nonstop hookah session. This discovery has been validated by many researches [5, 6] where the blood of hookah smokers contains large amount of CO against the blood of conventional cigarette smokers. Every "puff" inhaled in a hookah session contains ten times the volume of CO in cigarettes smoking. Generally, hookah smoking is seen as a treat to the public health due to its massive danger and the rise in number of its consumers. Because of such reason it was lately tagged by American Lung association as an 'emerging deadly trend' [4]. Regardless being acquainted with the effects of hookah smoking, a study discovered that most starters of hookah smoking are convinced that smoking cigarette is additionally compelling than smoking hookah [8]. It has been pointed out by a review captured recently in Journal of the International Union of Tuberculosis and Lung Disease, that tobacco industries use tactics to reintroduce a mode of tobacco consumption by promoting hookah smoking. Aside numerous perverts and errors, a selection of cancer studies outlined the fact that hookah smokers were concurrent or quitters of various tobacco products [9]. Research has shown that hookah consumption has been presumed to be a likelihood determinant for various cardiovascular diseases gotten from tobacco including cancer of the lung [10] and esophageal cancer [11] [12]. Various investigations have shown that hookah smoking is a vital determinant for cardiovascular disorders due to the high amount of nicotine present in the tobacco smoked from a hookah device [13]. The effects of nicotine on the

cardiovascular systems are associated to catecholamines, which are released as a result of nicotine which is binded to the nicotinic cholinergic gate on the cation channels in receptors (nAchR) across the body. It was reported by Symala et al., [14] that nicotine is retained for some much time in the bloodstream and in some particular vital tissues, including the heart through a persistent consumption of the substance. Very much electrophysiological changes or ECG changes might be witnessed due to presence of nicotine in the heart. The representation of the electrical activity of the cardiac muscle which varies with time is referred to as ECG. Ischemic stroke and a heart attack are heart disorders which are highly associated with smoking; hence hookah smoking could be a major determinate for such types of disorders. Sudden coronary death is also associated with a major content of tobacco which is the nicotine [13]. The content, amount, time and persistence of smoking determine the extent of damage smoking does to the cardiovascular system [15]. It is well known that the rise in systolic and diastolic blood pressure can be produced due to the consequences of smoking. The smoking consequences also include the increase in tachycardia, cardiac output and vasoconstriction, increase in carotid artery occlusion, and sometimes instantaneous Myocardial infarction (MI). The diastolic function and performance of the left ventricle have been connected as an important parameter used in clinics for diagnosing damages in the heart muscles [16].

Recently, there has been risen interest on the consequences of smoking on the heart diastolic performance, and a dystolic dysfunction was seen using an echocardiography method in accessing a Coronary artery disease (CAD) patient during continuance smoking [16].

In this study, the recorded ECG was processed on MATLAB 2013B software and was measured using a QRS localized and it was further measured using wavelet transform method.

II. MATERIAL AND METHOD

A. Study Participants and Design

Twenty hale volunteers within the age range of 18-28 years were recruited for the study. Volunteers attended outpatient department of Istanbul University. The duration of this study lasted for over 5 months. The subjects were subsequently grouped as smoker and nonsmoker, in accordance to the 10th revision of world health organization (WHO) International Statistical Classification of Diseases and related health problems [17]. Out of the volunteers, 10 smokers were selected and 10 others were non-smoker subjects that do not show any symptom of sarcoidosis. The smoker's subjects used in the experiment were chronic hookah users that have being smoking hookah for a period not less than six months and have not shown a symptom of any smoking related diseases. Healthy non-smokers were used as control group in the experiment, absence of major illness from the pass and presence was an inclusion criterion. Information on the harmful effect of smoking was given to the various volunteers of the both groups and written consent was taken from them.

B. ECG recording

The ECG recording of the two groups (smokers and nonsmokers) were obtained in the biomedical laboratory of Istanbul University. The subjects were urged to refrain from drinking alcohol, smoking or chewing tobacco and caffeine 2 hours prior to the time of recording. With the subject in the sitting position, a 3-lead electrocardiogram was recorded by using a single channel ECG cardiant [18]. The standard 3-lead ECG requires that 3 ECG leads were attached to the patient's body. The nonsmokers' subjects were recorded in a sitting and relax position while the leads were attached to the subject's body. While for the smokers' subjects two recordings was done for each subject. ECG was recorded before smoking and during smoking. The ECG recorded during smoking was done after ten minutes of hookah smoking.

Analyses of the processed data were carried out by IBM SPSS statistics software VERSION 20.0 The heart rate, RR interval, PR interval and QRS complex (millivolts), and QRS duration were evaluated. The obtained data was tabulated and statistically analyzed by using various standard statistical methods like calculation of mean and standard deviation was done. Calculation of the P value was done and the significance of each parameter was determined.

III. EXPERIMENTAL RESULTS

The data collected were processed in MATLAB 2013B software using continues wavelet transform (CWT) method. Using the wavelet transform it shows that the color results for nonsmokers' subjects show high frequency of QRS part than the smoker subjects. The color frequency of the QRS part tends to reduce further during smoking.
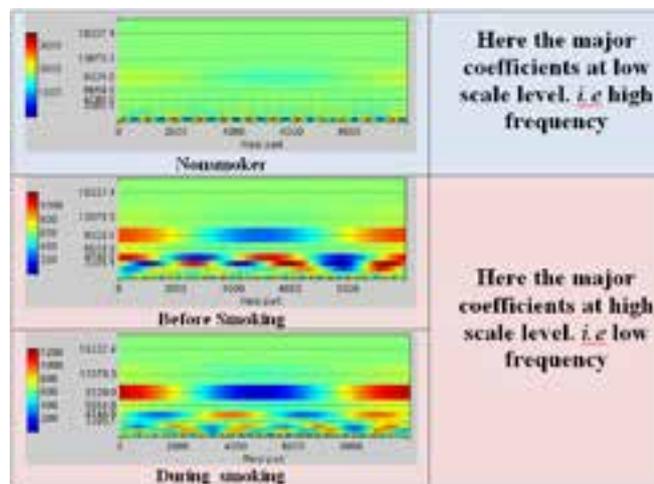

Fig. 1. CWT comparison in smoking subjects and nonsmoking subjects.

Parameters	Before smoking (n-10)	During smoking (n-10)	P-value (t-test)
Heart Rate	74.30±6.31	84.20±4.02	0.0312p < 0.05*
RR interval (ms)	673.17±32.24	785.64±57.26	0.0427p < 0.05*
QRS amplitude (mV)	0.926±0.0078	0.945±0.0089	0.093 p > 0.05
PR interval	0.0622±0.041	0.1058±0.0287	0.1610 p> 0.05
*= Statistically significant			

Table 1. Parameters of ECG analysis before and during smoking.

The above shows the result of various ECG parameters which were analyzed. The heart rate significantly increased in smoking subjects. Increment was also observed in QRS complex amplitude, RR interval and PR interval.
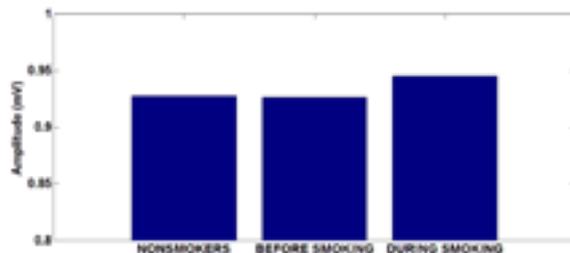

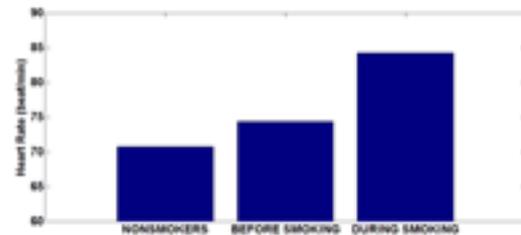**Fig. 2**. QRS complex amplitude (mV) before and during smoking.

Fig. 3. Heart rate between nonsmoker's subject and smoking subjects.

QRS complex was detected by using Squaring function with patient-specific threshold on MATLAB. The Hamilton-Tompkins algorithm applies a squaring function to rectify the differentiated ECG. The R-R interval , PR interval , QRS complex duration and QRS complex amplitude were further estimated and analyses was done by comparing Nonsmoker(control) and smoker (Before and during smoking) which is indicated as NS,SA and SB respectively. Below are some examples of MATLAB QRS localized results.
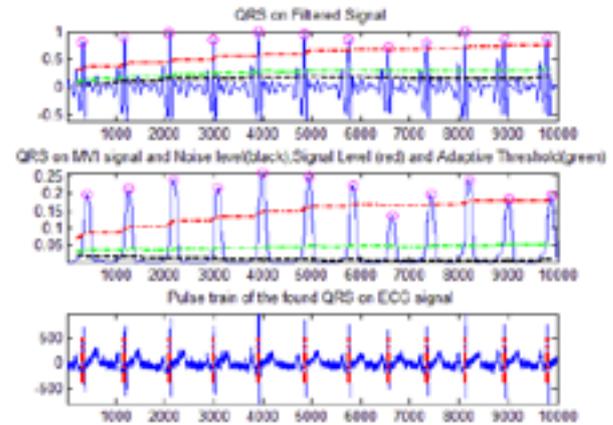

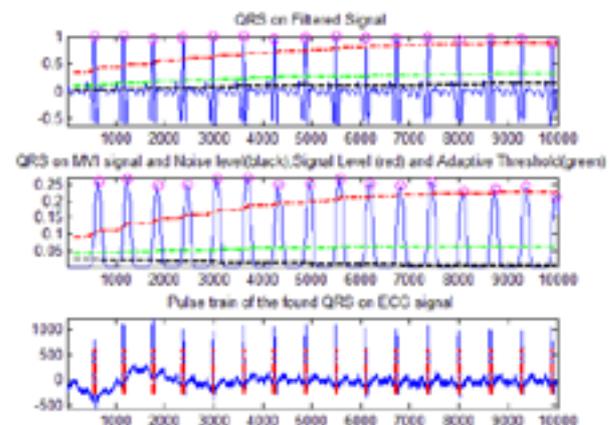**Fig. 4**. QRS localized result of a nonsmoker subject

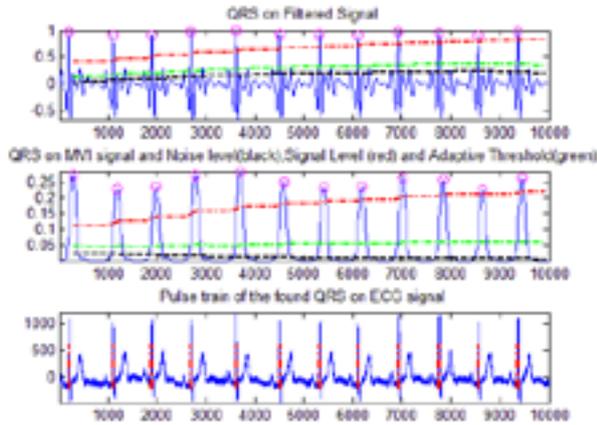**Fig. 5**. QRS Localized result of a smoker subject before smoking.

Fig. 6. QRS localized of a smoker subject during smoking

IV.   CONCLUSION

From the statistical analysis of the results obtained in this study and their comparison with those of the earlier published reports, it may be concluded that, smoking Hookah causes some significant changes in ECG. The changes caused because of hookah smoking have a great effect on the health which gives rise to many cardiovascular diseases and arrhythmias. However, to establish this further, there is need for undertaking a wider study covering different segments on the basis of the duration spent in a hookah session per day, and coupled with other risk factors.

Various changes observed in this study were results of persistent and terrible consequences of hookah smoking that may result into chronic cardiovascular disorders. These abnormalities could be identified with the help of a simple noninvasive tool by determining the wave amplitude and duration of ECG, which could have been used for sensitization programs by Non govermental organisations (NGO) and doctors to create awareness regarding danger of hookah smoking to the smokers and the hookah smokers should quit smoking as early as possible.

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