Original Article

Effect of Smoking on the Red Blood Cell Count, Hemoglobin Concentration, Hematocrit and Red Cell Indices in Adult Male Smokers

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Abstract

Background- *Cigarette smoking is one of the common addictions. The effects of cigarette smoking on health are serious and, in many cases, deadly.* ***Objectives:*** *The present study was carried to observe the effect of smoking on Red Blood Cells (RBC) count, Hemoglobin (Hb) concentration, Hematocrit (HCT) and Red cell indices in adult male smokers and compare it with non-smokers to create awareness.* ***Materials and Methods:*** *In this study 50 adult male smokers and 50 adult male non-smokers aged from 20-45 years were taken. The smokers were regularly smoking for at least one year. Fresh peripheral blood sample from subjects were collected and analyzed for Red blood cell count, Hemoglobin concentration, Hematocrit and Red cell indices by using Mythmic-22 automated 5-part Hematology Analyzer.* ***Result:*** *In this study the values of RBCs count, Hb concentration and Hematocrit showed significant increase ($p<0.05$) in smokers as compared to non-smokers. The values of Red cell indices (MCV, MCH, MCHC) were statistically not significant between two groups.* ***Conclusion:*** *This study concluded that smoking causes persistent state of hypoxia in the body due to smoke contents which cause increase in RBCs count, Hb concentration and Hematocrit.*

Key words: Smoking, Red blood cell count, Hemoglobin, Red cell indices.

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Introduction

Smoking is the inhalation of the smoke of burned tobacco that may occur occasionally or habitually as a consequence of physical addiction to nicotine[1]. A smoker is a person who smokes any tobacco product either daily or occasionally. Daily smoker is a person who smokes any tobacco product at least once a day and occasional smoker is a person who smokes but not every day. Non-smoker is a person who does not smoke at all[2].

Cigarette smoking is one of the major leading causes of death throughout the world. As per WHO report, it was presumed that tobacco smoking killed 100 million people worldwide in 20th century and warned that it could kill one billion people around the world in the 21st century. Tobacco related diseases are rising in developing countries[3]. Cigarette smoking carries higher risk for most of the chronic diseases. It increases risk for developing atherosclerosis, polycythemia, chronic obstructive pulmonary diseases and cardiovascular diseases. Cigarette smoking has both acute and chronic effect on hematological parameters. There are more than 4000 chemicals found in cigarette smoke[4], and a cigarette smoker is exposed to a number of harmful substances including nicotine, free radicals, carbon monoxide (CO) and other gaseous products[5]. The combination of CO in tobacco with effects of nicotine disrupts oxygen delivery to tissue and stimulate bone marrow to produce more RBCs and thereby increases Hematocrit (HCT) and Hb[6].

High level of RBC (>7 million cells/microlitre) is termed as polycythemia and very high RBC mass slows blood velocity and increase the risk of intravascular clotting, coronary vascular resistance, decreased coronary blood flow and a predisposition to thrombosis[7]. Some scientists suggested that increase in Hb level in blood of smokers could be a compensatory mechanism[8-10]. This study aimed to determine the effect of smoking on RBC count, Hb concentration, HCT and Red Cell Indices to create awareness in public about the deleterious effect of smoking on health.

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Materials and Methods

This cross-sectional comparative study was carried out in the department of physiology of Rajshahi Medical College from July 2015 to June 2016. Total 100 apparently healthy subjects age ranged from 20-45 were selected of whom 50 were smokers and 50 were age, sex, and BMI matched non-smokers for comparative with study group. Individuals with history of smoking cigarettes daily for at least one year were considered as smokers. Ex-smokers or past smokers were excluded from this study.

Subjects suffering from any acute or chronic respiratory illness, renal disease, hypertension, diabetes mellitus, any infections or debilitating illness were excluded. Persons taking drugs such as antibiotic, aspirin or taking radiotherapy and subjects who drink alcohol were also excluded.

All the subjects were explained about the aims and objectives of the study and the test procedures were briefed and written informed consent was taken from the subjects before performing the test. After obtaining the informed consent physical parameters like blood pressure, pulse and anthropometric parameters were measured which include height and weight. A detailed history of smoking was obtained by using a pre-tested questionnaire.

Venous blood was collected in the morning hours from each person to avoid the effect of diurnal variation on blood counts. 5 ml of blood were collected into a syringe with all aseptic precautions and mixed with anticoagulant EDTA and automated counting was done using by Mythmic-22 automated 5-part Hematology Auto-analyzer. Raw data was collected from the auto-analyzer and statistical analysis was done by SPSS software program.

Results

A total number of 100 healthy adults (50 smokers and 50 non-smokers) were selected according to the inclusion and exclusion criteria for the study.

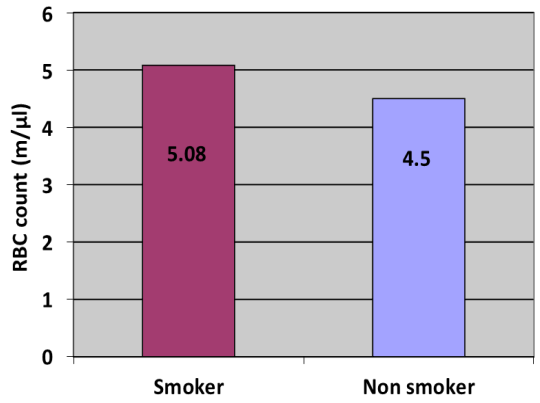

Figure-1: Bar diagram showing red blood cell count in healthy adult smoker group and non-smoker group

Hematological parameters were done by auto analyzer in all individual of this study and then tabulated and analyzed. All the variables were expressed as mean±SD (standard deviation) and students unpaired t-test was done to compare among the groups. P value at or below 0.05 are representing statistically significant results.

Table-I: General characteristics of the study subjects (n=100)

Parameters	Smokers [n=50] Mean ± SD	Non-smokers [n=50] Mean ± SD	p-value
Age (years)	30.54±6.37	30.12±6.31	>0.05
Weight (Kg)	64.16±6.32	64.38±6.62	>0.05
Height (cm)	165.72±3.33	166.10±3.48	>0.05
BMI (Kg/m^2)	23.30±2.15	23.19±2.13	>0.05

n=number of research participants, BMI=Body Mass Index

Table-I showed distribution of different parameters of study subjects as age (years), weight (kg), height (cm), BMI (kg/m2). Values of the basic characteristics were expressed as mean±SD.

Table-II: Hematological parameters between the smokers and non-smokers group (n=100)

Parameters	Smokers [n=50] Mean ± SD	Non-smokers [n=50] Mean ± SD	p value
RBC (m/µl)	5.08±0.28	4.50±0.30	<0.05
Hb (gm/dl)	4.04±0.74	12.93±0.76	<0.05
Hemato-crit (%)	42.51±2.09	40.09±1.30	<0.05
MCV (fL)	86.59±4.98	84.98±4.90	>0.05
MCH (pgm)	28.26±2.16	27.90±2.00	>0.05
MCHC (gm/dl)	31.51±1.19	31.66±0.96	>0.05

n=number of research participants

Table-II showed the changes in RBC count, HCT, Hb concentration and Red cell indices of smokers and non-smokers. Smokers group had a statistically significant increase in the mean values of RBC count ($p<0.05$), Hb concentration ($p<0.05$), HCT

($p<0.05$). Whereas there was no significant difference was observed in MCV, MCH, MCHC ($p>0.05$) between smoker and non-smokers.

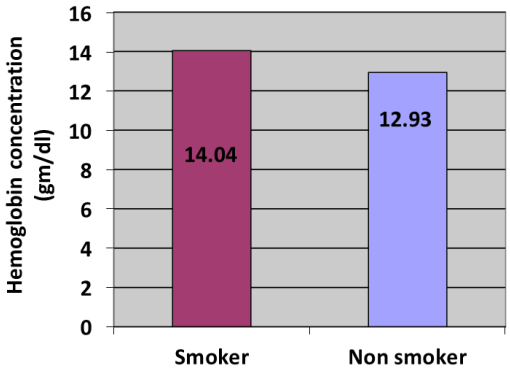

Figure-2: Hemoglobin concentration in healthy adult smoker group and non-smoker group

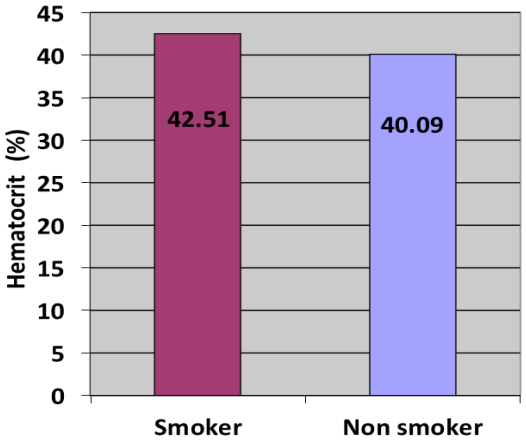

Figure-3: Bar diagram showing hematocrit in healthy adult smoker and non-smoker group

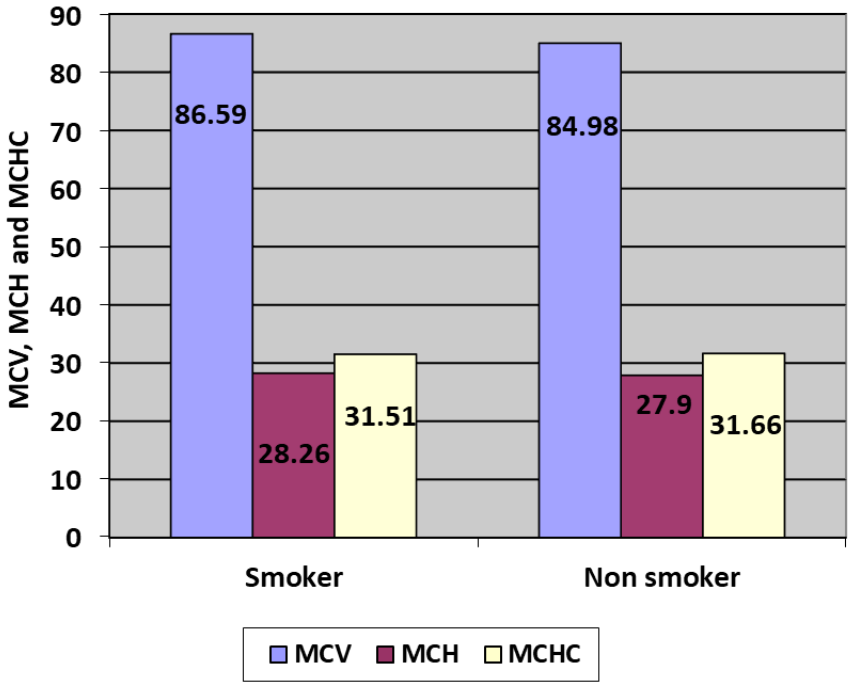

Figure-4: Bar chart showing MCV, MCH and MCHC in healthy adult smokers and non-smokers group

Discussion

The study showed that total count of RBC, hemoglobin concentration and hematocrit levels were increased significantly among smokers in comparison to non-smokers. These findings are compatible with several other investigators[11-17]. These effects are possibly secondary to hypoxic stimuli exerted by smoking[16,17].

Carbon monoxide (CO) found in cigarette has 245 times more affinity for hemoglobin than oxygen[2,10]. Thus, CO displaces oxygen from hemoglobin in the red blood cells to produce carboxyhemoglobin[3,12]. This carboxyhemoglobin does not have any oxygen carrying capacity[11]. That reduces the release of oxygen to tissue. So, there is compensatory rise of erythropoietin secretion to cope the tissue hypoxia by increasing more erythrocyte production. Thus, the increase in hematocrit and hemoglobin concentration levels following such increase in erythrocyte production are quite obvious. CO increase capillary permeability that decreases plasma volume which mimics polycythemia[3,11,12].

It is reported that high level of RBC and hematocrit are associated with blood viscosity and clotting in smokers[15,18]. High level of RBC (>7 million cells/microlitre) is termed as polycythemia and very high RBC mass slows blood velocity and increased the risk of intravascular clotting, coronary vascular resistance, decreased coronary blood flow and a predisposition to thrombosis[7]. This elevation may

lead to congenital heart disease, pulmonary fibrosis and elevated erythropoietin[19-21]. The mechanism by which the polycythemia causes thrombosis is still under investigation but smoking cigarettes creates a unique condition of combined polycythemia to chronic hypoxia leading to elevated red cell production due to an elevated carboxyhemoglobin level, with concomitant plasma volume reduction[18,20]. Overall thrombosis is a serious complication of polycythemia and can lead to death up to 8.3% of patients[7,22].

However some researcher failed to find out any effect of smoking on RBC and hemoglobin concentration[22-24]. It may be due to the fact that the duration of smoking was less among their study subjects[23]. So studies are needed to find out acute as well as chronic effect of smoking on hematological parameters. Additionally tell et al. have observed gender variation about effect of smoking on the hematocrit which indicates the importance of further research activity[25].

MCV, MCH and MCHC are three main red blood cell indices that help in measuring the average size and hemoglobin composition of the red blood cells[22]. In this study we did not find any significant changes in these indices among smokers and non-smokers. These findings correlate with several other investigators[13,24,25]. This can be explained by the younger age group and small sample size and subject with relatively less duration of smoking in our study.

This study findings clearly show that continuous cigarette smoking has several adverse effects on hematological parameter. In our result Hb, hematocrit and RBC counts are significantly higher in smokers than non-smokers and this may be a good early indicator for developing cardiovascular disease in smokers. Because too many blood cells can make the smokers blood more viscous, so the blood does not flow efficiently and can contribute to the formation of clots[17,24]. This can increase the risk of clotting complications such as stroke, heart attack, deep vein thrombosis or pulmonary embolism[22]. Hence smoking is considered as one of the major avoidable risk factors for cardiovascular disease and death[25]. Encouraging result have been observed in smokers who showed a rapid return of many hematological abnormalities towards normal on abstention from smoking[22-24]. Also the risk of adverse effects starts to decline quite rapidly after cessation of smoking[23,25]. This fact is of immense importance for the young smokers who are otherwise free from other predisposing factors like obesity, hypertension, diabetes, etc.[25]. So, they have a bright future provided they exercise their will to stop smoking.

Conclusion

This study concluded that smoking causes persistent state of hypoxia in the body due to smoke contents which cause significant increase in RBCs count, Hb concentration and Hematocrit. So early smoking cessation is very much helpful to avoid cardiovascular disease and its complications.

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