

## **Study of Carotid Atherosclerosis in Smokers**

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### **Abstract**

Since smoking is an important public health problem, The objective of this study was to explore smoking powerful association with carotid atherosclerosis. In observational cross-sectional study, 121 participants were investigated by B- mode and Doppler ultrasound at king Abdul Aziz specialty hospital –Taif, KSA (2011-2013). 92 of the participants were smokers and 29 were control group. The mean age was  $40.9 \pm 21.5$  (range from 19 to 100 years old). Carotid arteries for all participants were examined using 7MHz linear transducer according to the carotid ultrasound protocol. The frequency of carotid plaques was 22.8% (of 92). The high frequency registered in group that smoke > 20 cigarettes per day. All plaques were presented in population of age above 53 years old. There was association between duration of smoking and the presence & increases of plaque size,  $P = .002$ . The mean thickness of IMT in smokers was  $.8362 \pm .37$  mm. While it was .5 mm in control group. There was strong statistical association between the frequency of smoking and the increase in IMT,  $P = .000$ . The study suggested that there is a significant association between carotid atherosclerosis and smoking. Also carotid plaque may present at age of 54.

**Keywords:** Carotid artery, Atherosclerosis, Ultrasound, Smoking.

### **1 Introduction**

There are so many fatal diseases attack human body, one of these is a stroke which is considered to be the second top leading causes of deaths worldwide WHO reports [1]. Stroke may result from blockage or rupture of the arteries that supply the brain. Since carotid arteries are the main source of brain supply, this clarifies the importance of studying their abnormality specially the atherosclerosis.

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The relationship between extracranial carotid disease and stroke was emphasized since 1914 (Niten S. et al. [2] Atherosclerosis is a degenerative disease of the arteries resulting in plaques consisting of necrotic cells, lipids, and cholesterol crystals. These plaques can result in symptoms by causing a stenosis, emboli, and thrombosis, Moore WS [3] Carotid artery atherosclerosis is a common feature, which is developmentally and anatomically is indistinguishable from atherosclerosis in the other arteries. In population, the main risk factors of carotid artery atherosclerosis are the same as those of other atherosclerotic diseases, (Berglund et al. [4]).

Smoking represents one of the crucial risk factors for carotid atherosclerosis. The prevalence rate of carotid atherosclerosis increased with age and smoking (Bonithon-Kopp C et al. [5] Current smoking in Saudi Arabia considered to be of high rate in Saudi males which is about 26.5 % and the tobacco- related health problems cost 176 billion Dollars per year in KSA. Medhat M. [6]. This indicates the significance of studies have relation with this problem, like carotid atherosclerotic changes.

Objectives behind this study; to assess the prevalence of carotid atherosclerosis in male Saudi smokers using B- mode & Doppler ultrasound. Moreover to compare this prevalence between elderly and young smokers.

## **2 Preliminary Notes**

### **2.1 Definition**

KSA = Kingdom of Saudi Arabia  
CCA = Common carotid artery  
ICA = Internal carotid artery  
IMT = Intima media thickness

## **3 Materials and Methods**

### **3.1 Study Design and Population**

This is an observational cross-sectional study, it conducted through Feb. 2011 to June 2013 at king Abdul- Aziz Specialty Hospital in KSA. The populations are Saudi smokers, the sample size was 121 participants (92 smokers and 29 were control group). Inclusion criteria was male Saudi smokers. Exclusion criteria included patients with coronary artery or cardiac diseases. High blood cholesterol level, obesity and hypertension were considered factors. The sampling technique used was systemic simple convenient sampling to select all the study population.

### **3.2 Ultrasound Technique & Measurements**

B- mode and color Doppler ultrasonography measurements was used to examine all participants. ACUSONX300 ultrasound machine with 7MHz linear transducer was used to examine carotid arteries of all participants according to the carotid ultrasound protocol (Paul L Allan et al. [7]).

The guided reference for CCA IMT was as following; IMT is considered normal when it

is (less than 1.0 mm), moderate thickness is considered when the IMT is (less than 2.0 mm), and signs of carotid plaque when (IMT is more than 2.0 mm). (Duplyakov Dmitry et al. [8]).

### 3.3 Data Collection

Information about smoking was obtained by a questionnaire. All participants were asked if they had ever smoked and if so; whether they were current smokers or not. The type and frequency of smoking per day was also registered for current smokers. The participants were classified into two groups according to the frequency range of smoking per day (from 1 to 20 or >20 cigarettes per day).

The sonographic data was obtained through direct ultrasound scanning of carotid arteries for the participants bilaterally (For both smokers and control group).

### 3.4 Statistical Analysis

SPSS 16.0 For Windows Evaluation Version statistical system was used in analyzing the processes of the findings. Chi-Square Tests were applied to achieve the statistical values of relation between smoking and the presence of carotid atherosclerotic changes.

## 4 Main Results

121 participants were included in the study (92 smokers and 29 were control group). The mean age was  $40.9 \pm 21.5$  (range from 19 to 100 years old). 12% of the smokers were hypertensive and 4% were of high cholesterol level. Table 1 summarizes the frequency of carotid plaques which was 22.8% (of 92). The detail of this prevalence was as follows; 9.5% in participant with high cholesterol level, 33% in hypertensive and 57.5% in participants under the risk of smoking only. Figure 1 summarizes the comparison between presence of plaques in participants smoke  $\leq 20$  cigarettes per day and those who smoke  $> 20$  cigarettes per day, the higher percentage of plaques was in the group that smoke  $> 20$  cigarettes per day. There was strong statistical association between duration of smoking and the presence of plaques,  $P = .002$ , while there was no statistical association between the frequency of smoking and the presence of plaques,  $P = .093$ .

Regarding the statistical analysis of association between age and presence of plaques & the increase of plaques' sizes, there were positive associations ( $P = .007$ ) and ( $P = .000$ ) respectively. There was statistical association between duration of smoking and the increase in plaque size, ( $P = .000$ ).

Table 2 summarizes the frequency of stenosis, 15.5% (of 92) 14 had stenosis. 13% had stenosis  $< 50\%$  and 5.4% had stenosis from 50 – 79%. While 2.2% (of 92) had total occlusion.

The mean thickness of IMT in smokers was  $.8362 \pm .37$  mm. While it was .5 mm in control group. There was statistical association between the frequency of smoking and the increase in IMT, ( $P = .000$ ).

Figure 2 summarizes the representative comparison between blood velocities in young smokers and young control group (19 to 29 years old), through hemodynamic assessment of carotid PSV. The mean PSV in smokers were 60.5, 57.4, 76.0 in CCA, ICA and ECA

respectively. For the control group the PS velocities were 58.1, 55.6 and 68.4 in CCA, ICA and ECA respectively.

Figure3 summarizes the distribution of the site of plaques, the common site was ICA.

Figure4 through 7 show the representative B- mode images of plaques, increase IMT and Doppler spectral analysis.

Table 1: Shows the frequency of plaques in smokers

Presence of plaques	Frequency	percentage
CCA	5	23.8
ICA	8	38.2
Bifurcation	5	23.8
Bifurcation & CCA	1	4.7
Bifurcation & ICA	2	9.6
Total	21	100

Table 2: Shows the frequency of stenosis in the participants.

Status of stenosis	Frequency	percentage
No stenosis	73	79.3
Stenosis < 50%	12	13.0
Between 50 - 79%	5	5.4
Total occlusion	2	2.2
Total	92	100.0

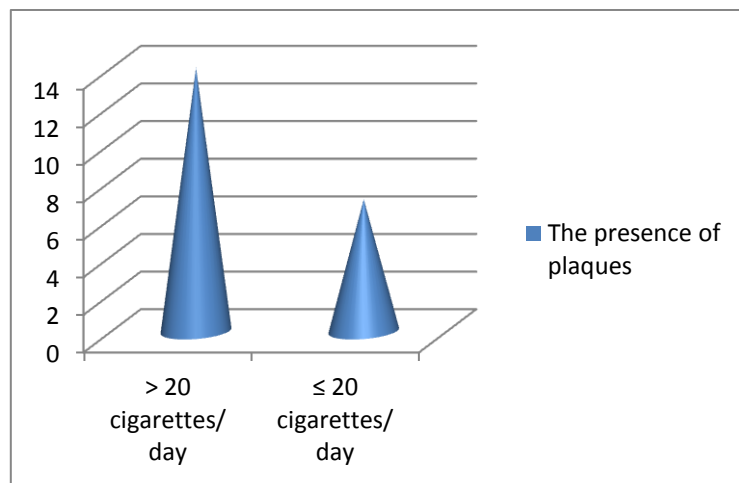


Figure 1: The presence of plaque in relation with the frequency of smoking in the participants.

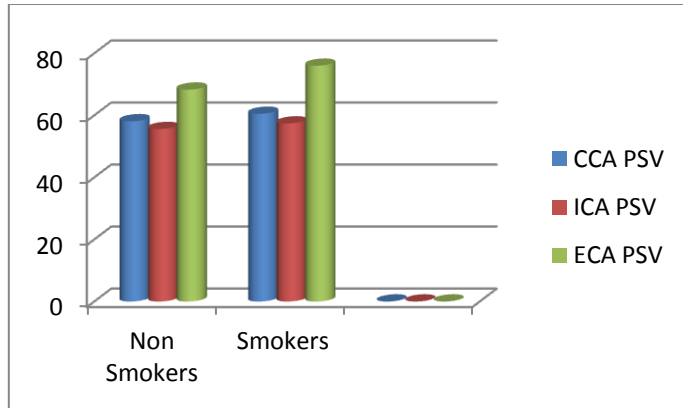


Figure 2: A representative comparison of carotid artery velocities between the control group and smokers. Note the increase velocities in smokers.

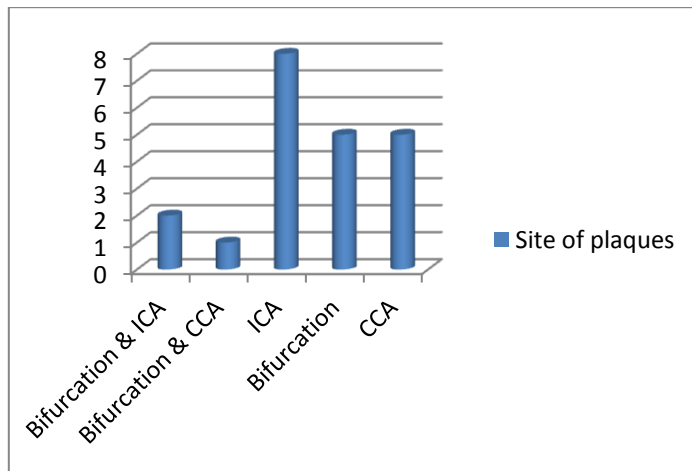


Figure 3: Shows the site of plaques distribution.

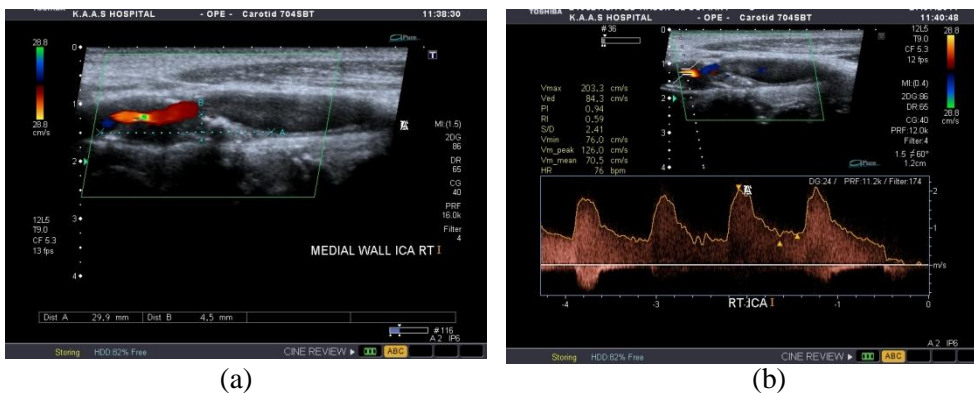


Figure 4: Internal carotid plaque and stenosis in 55 years old heavy smoker: a. B- mode image with mixed echotecture plaque in ICA. b. Spectral Doppler analysis shows increased carotid velocities with sign of (50% - 79%) stenosis.

## 5 Discussion

Carotid atherosclerosis may have association with smoking and ischemic arterial diseases. This is beside other risk factors such as; age, gender, systemic hypertension, obesity. This study aimed to evaluate the association of carotid atherosclerosis with smoking in Saudi smokers.

The study suggested that there is strong statistical significant association between the smoking and the occurring of carotid plaques,  $P = .002$ . The frequency of plaques in participants smoke  $> 20$  cigarettes per day was the higher frequency. These findings were totally agree with (Lassila et al. [9]) results who showed that smoking had a strong association with the presence of plaque. Also agree with (Luc Djoussé et al. [10]) results who suggested that the prevalence odds ratios for carotid atherosclerosis were 1.7 and 1.9 for current smokers of 1 to 20 cigarettes per day, and current smokers of  $>20$  cigarettes day, respectively.

Previous author has suggested that the presence of carotid atherosclerosis is associated with age  $\geq 64$  years old (Porto Alegre) [11] that is in contrast to the results of this study, which showed plaques in ages less than 64 years old (Figure4).

Regarding the size of plaque this study suggested that there was association between the duration of smoking and age with increases in plaque thickness,  $P = 0.000$ . These finding confirm the results of (RJ Dempsey et al. [12]) who reported that increase in age is associated with smaller increases in plaque thickness.

The results of this study suggested that smoking has effects on hemodynamic in carotid artery (Figure2) these findings match Sofka, Carolyn [13] results who suggested that the acute smoking causes Hemodynamic Alterations in the Common Carotid Artery.

The study findings suggested that there is strong association between the frequency of smoking and the increase thickness of IMT ( $P = .000$ ). These findings agree with (Amy Z Fan, et al. [14]) who showed that IMT of common carotid artery (CCA-IMT) and its components (echogenic and echolucent layers) in current smokers was associated with thicker echogenic layer than never smokers.

Some previous authors have proposed that carotid bifurcation is the common site of plaques (Paolo Rubba et al. [15]) while this current study findings suggested that the ICA carotid is the common site of plaques (Figure 3).

## 6 Conclusion

This study concluded that there is a significant association between carotid atherosclerosis and smoking. Moreover it suggested that carotid plaque may occur in early ages among smokers around 54 years old. The researchers recommended that further studies were needed.

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