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To Assess Skin Blood Flow Response to Breath Holding in Smokers

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Original Research Article

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Abstract: Endothelial dysfunction causing pathologies associated with smoking alters blood flow to the skin. Skin blood flow is controlled through the release of compounds by vascular endothelium. The changes in peripheral blood flow are attributed to sympathetic discharge during breath holding in smokers. The objective of this study was to compare skin blood flow in smokers and non-smokers at rest and during breathe holding and to correlate alterations with duration of smoking. 50 smokers and 50 non-smokers without any history of respiratory disease, cardiac disease or any other chronic disease were included in the study. Careful monitoring of blood flow to the index finger was done. Readings at rest during normal breathing, during breath holding and just after first breath were recorded. A total of 50 smokers and 50 non-smokers were included in the study .The mean resting index finger blood flow was found to be greater in smokers (525 ± 200) when compared with control subjects (448 ± 197). The blood flow in controls and smokers during breath holding was (257 ± 141) and (338 ± 185) respectively and the difference was statistically significant (0.015).it was found that the people who were smoking for more than 10 years show higher resting blood flow (570 ± 203) and also during breath holding (364 ±213) when compared with the people smoking for less than 10 years which was (459 ± 178) and (300 ±128) during rest and breath holding respectively. Our findings indicate that the mean index finger blood flow was found to be significantly greater in smokers than control subjects which increased proportionately with the duration of smoking.
Keywords: Breath holding Skin blood flow Smoking

INTRODUCTION

Endothelial dysfunction is a common denominator in much pathology in man. It is associated with aging, diabetes, high blood triglycerides, cigarette smoking, and other contributors to inflammation [1-5]. Numerous factors can influence resting blood flow. The vascular endothelial cell controls the contractile state of vascular smooth muscle [6] through release of compounds by vascular endothelium. These compounds control contractile state of vascular smooth muscles.

Smoking tends to increase blood cholesterol levels, raised fibrinogen levels and platelet count which makes the blood stickier and all these factors make smokers more vulnerable to atherosclerotic diseases. As the disease progress blood flows less easily through narrowed and rigid arteries leading to increased risk of heart attack, stroke and gangrene.

In man with normal neurovascular status the response to a respiratory act like breath holding is brought about by chemical and mechanical factors both of which feed into reflex pathways [7]. The effect of breath holding on peripheral vascular bed in normal subjects is already established and changes are attributed to sympathetic discharge whether or not such changes are present in smokers is not yet established.

REVIEW OF LITERATURE

- Meekin TN; Wilson RF *et al.* [19] conducted a study to determine the effect of the smoking experience on relative blood flow in gingiva and to compare this to skin. The results do not seem to support the theory that tobacco smoking causes localised vasoconstriction in the periodontal tissues in humans. These data show that smoking causes an acute increase in relative blood flow in forehead skin in light smokers compared to heavy smokers, suggesting a potential induction of tolerance in regular users of tobacco.
- Mavropoulos A *et al.* [20] found that resting Gingival blood flow of periodontitis patients was not lower in smokers than in non-smokers,

but it was significantly lower than in the younger reference subjects. In contrast to our earlier findings in healthy subjects, smoking one cigarette may cause a decrease in Gingival blood flow in periodontitis patients. These observations suggested the existence of a dysfunction in the gingival vasculature in smokers and non-smokers with periodontitis.

- Blank *et al*. [21] reported an increase in BP and HR as well as plasma nicotine concentration. Additionally, changes following cigarette smoking indicated that the elevated nicotine mediates an increase of sympathetic nervous system activities and a release of epinephrine, norepinephrine *[22-24]* and vasopressin *[25]* hormones. This sympathohormonal-excitatory response mediated the increase in the central components of the cardiovascular system.
- Sørensen LT *et al.* [26] studied Acute effects of nicotine and smoking on blood flow, tissue oxygen, and aerobe metabolism of the skin. They concluded that Nicotine has a limited vasoactive effect in the skin and subcutis unlikely to be explained by smoking, which distinctly decreases tissue blood flow, oxygen tension, and aerobe metabolism independent of smoking status.
- Uehara K *et al.* [27] examined the physiological responses, including skin vasomotor responses, to smoking and exercise in six healthy smokers. It was suggested that long-term mental stress and smoking behavior may synergistically develop chronic stress-induced vascular dysfunction, and the stress-related disorders may be reduced by habitual enforcement of moderate exercise.
- Rossi M; Pistelli F *et al.* [28] studied Impact of long-term exposure to cigarette smoking on skin microvascular function. This study confirmed that smoking is associated with cutaneous microvascular dysfunction and shows that the severity of this impairment is independently related to the duration and intensity of the exposure to smoking.
- Midttun M *et al.* [18] studied the effect of smoking a single cigarette on the blood flow rates in capillaries and arteriovenous anastomoses (AVAs) in light and heavy smokers and concluded that Smokers have severely disturbed peripheral microcirculation.

Aims and Objectives

- To assess and compare skin blood flow in smokers and non-smokers at rest
- To assess and compare skin blood flow in smokers and non-smokers during breathe holding
- To correlate the alterations in blood flow with the duration of smoking

MATERIAL AND METHODS

The present case control study was conducted In the Dept. of Physiology, BPS GMC for Women, Khanpur Kalan, in collaboration with Central Research Laboratory. 50 smokers (cases) and 50 non-smokers (controls) subjects coming tohospital either for their own treatment or their relatives' and the supporting staff in the age group of 18-40 years of age were considered for the present study.

All subjects were instructed to practice breath holding for some time. Then subjects capable of holding their breath for 45-60 seconds were included in the investigation. Subjects who are known cases of hypertension, other cardiovascular ailments, diabetes, asthma or other respiratory disorders, history of long term use of medication and other acute or chronic diseases were excluded from the study.

After obtaining written informed consent from all cases and control subjects fingertip blood flow response to a breath holding of 45-60 seconds duration was assessed non-invasively thrice i.e.at rest, during breath holding and immediately after first breath. History was taken from all subjects & complete general and systemic physical examination was performed

The study was carried out in the morning between 9a.m. and 12 noon with the subject sitting on a chair where the temperature ranged between 22 and 23 degrees centigrade throughout the study period. The rate of skin blood flow was estimated using Laser Doppler blood perfusion monitor (LDF- 100C) used to measure real time micro-vascular red blood cell perfusion in tissue recorded in the form of BPU (Blood Perfusion Unit).

The readings taken from each subject while breathing normally i.e. at rest and during breath holding and immediately after first breath were averaged in both groups of subjects.
The smokers are further classified in to two groups based on their duration of smoking (< 10 years and > 10 years).

The readings taken from each subject while breathing normally and during breath holding were averaged in both groups of subjects. The coefficients of variation of the mean index finger blood flow in each testing condition were determined for each subject. Then the overall mean =S.D. was computed and test of significance performed using software SPSS Ver. 20.

RESULTS

The mean blood flow measured during normal resting breathing, during breath holding and immediately after first breath in both control and cases (smokers) is shown in following table.

Table-1: Showing blood perfusion units (BPU) in smokers (cases) and non-smokers (controls).

SUBJECTS	DURATION	Blood flow during rest (BPU)	P value	Blood flow during breath holding (BPU)	P value	Blood flow just after breath holding (BPU)	P value
SMOKERS	More than 10 years	570± 203	0.04	364± 213	0.18	532± 197	0.01
	Less than equal to 10 years	459± 178		300±128		404± 154	
	smokers	525± 200	0.05	338± 185	0.015	481± 160	0.32
NON-SMOKERS	Non-smokers	448± 197		257± 141		446± 160	

The mean index finger blood flow measured during normal breathing at rest and breath holding in both controls and smokers is shown in table. Coefficients of variation calculated for flow readings of both control and smokers showed only a small range of intra – individual variations. The mean resting index finger blood flow was found to be greater in smokers (525 ± 200) when compared with control subjects (448 ± 197) (p value=0.05)

The blood flow in controls and smokers during breath holding was (257 ± 141) and (338 ± 185) respectively and the difference was statistically significant (0.015). Breathe holding produced significant reduction in the index finger blood flow in both control subject and smokers.

When smokers were compared based on the duration of smoking, it was found that the person who were smoking for more than 10 years show higher resting blood flow (570 ± 203) and also during breath holding (364 ±213) when compared with the person smoking for less than 10 years which was (459 ± 178) and (300 ±128) during rest and breath holding respectively.

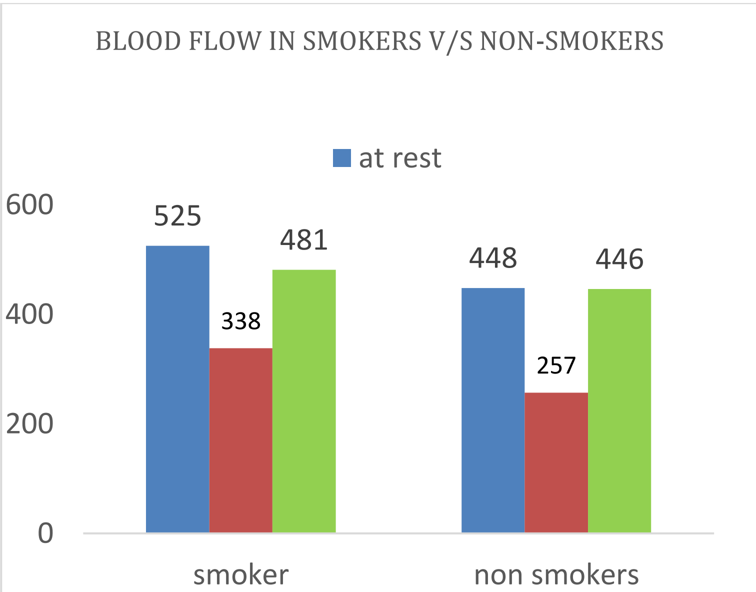

Fig-1: Blood flow in Smokers Vs Non-Smokers

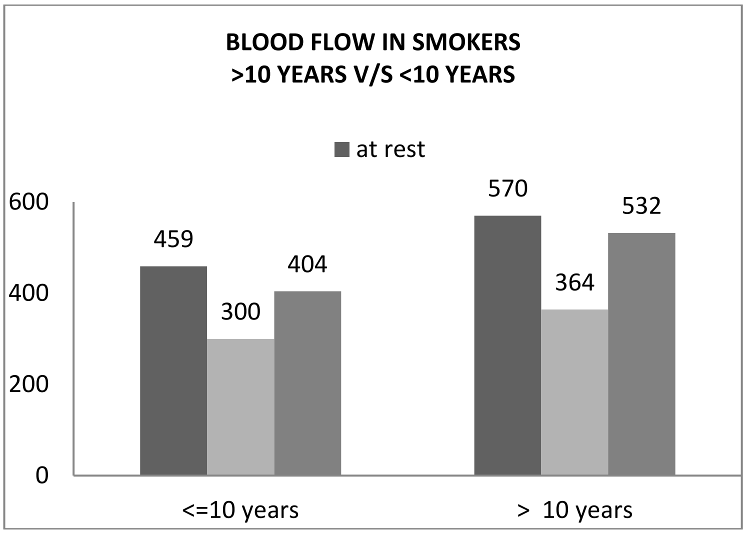

Fig-2: Blood flow in Smokers >10 years Vs <10 years

DISCUSSION

The mean index finger blood flow measured during normal breathing at rest was found to be significantly greater in smokers when compared with control subjects. Breathe holding produced significant reduction in the index finger blood flow in both control and subject smokers and the difference was statistically significant.

Another finding in the present study was that the duration of smoking was related with the mean index finger blood flow. It was found that the people who were smoking for more than 10 years show higher resting blood flow and also during breathe holding when compared with the person smoking for less than 10 years.

Regulation of skin blood flow represents a complex scheme of neural and non-neural vasoconstrictor and vasodilator signals controlled by multiple homeostatic mechanisms (e.g., thermoregulatory reflexes, baroreflexes)[8]. While the effects of hypoxia and hypercapnia on skin blood flow are poorly understood, it has been suggested that both stimuli cause vasodilation in human non-acral skin [9-12]. If this is so, then conditions characterized by low oxygen or high carbon dioxide levels (e.g., altitude, respiratory disease, smokers) may cause peripheral shifts in blood volume due to the high compliance of the cutaneous vasculature.

Evidences indicate that cutaneous vessels dilate in response to carbon dioxide. Interestingly, studies of forearm hemodynamics during systemic hypercapnia indicate that local vasodilation to carbon dioxide may be partially offset by sympathetic vasoconstriction mediated through chemoreceptor activation[13]. Therefore, the net hemodynamic response in the skin may also depend on the relative activation of vasoconstrictor and vasodilator signals.

During hypoxia, blood flow to the hand and fingers decreases [14, 15]. These observations lead to the belief that hypoxia causes cutaneous vasoconstriction because the hand and finger circulations are directed mostly to skin. However, both the structure and autonomic innervations of the cutaneous circulation in the hand are different than that of the hairy (non-acral) skin that covers most of the body surface [16]. Therefore, the vascular response to hypoxia in non-acral skin may be different from the responses in the hands and fingers [17].

CONCLUSION

Our findings indicate that the mean index finger blood flow was found to be significantly greater in smokers than control subjects. This mean index finger blood flow increased proportionately with the duration of smoking.

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