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The Effect of Tobacco Smoking on Kidney Functions of Hypertensive Patients

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ABSTRACT

Background: Hypertension is a global public health crisis and a primary risk factor for chronic cardiovascular and renal diseases. Tobacco smoking, a major preventable cause of hypertension, introduces harmful substances like nicotine that stimulate the sympathetic nervous system. This triggers vasoconstriction, increases blood pressure, and reduces the glomerular filtration rate. This study aims to evaluate the impact of smoking on renal function parameters among hypertensive patients.

Materials and Methods: This observational, cross-sectional study was conducted at MGM Medical College and Hospital, Navi Mumbai. The study population comprised 110 hypertensive patients, equally divided into two groups: smokers (n=55) and non-smokers (n=55). Renal function parameters and blood pressure were measured and compared between the two groups. Statistical analysis was performed using SPSS version 16, utilizing independent t-tests to compare mean values.

Results: The smoker group exhibited significantly higher blood pressure levels compared to the non-smoker group. The mean systolic blood pressure was 156.87 mmHg in smokers versus 150.25 mmHg in non-smokers ($p = 0.0083$), while mean diastolic blood pressure was 90.98 mmHg versus 88.36 mmHg ($p = 0.02578$).

Regarding renal function, smokers showed significantly elevated levels of mean serum urea (72.41 mg/dl) compared to non-smokers (44.08 mg/dl, $p < 0.05$). Mean serum creatinine was also significantly higher in smokers (1.25 mg/dl) than in non-smokers (0.91 mg/dl, $p < 0.05$). Notably, urine albumin was detected at Grade 3 (+++) in the smoker group, whereas it was absent in the non-smoker group. Serum uric acid levels showed no statistically significant difference between the groups (5.42 mg/dl in smokers vs. 5.39 mg/dl in non-smokers).

Conclusion: The findings indicate that smoking significantly exacerbates hypertension and impairs renal function, as evidenced by elevated serum urea, creatinine, and marked albuminuria. While baseline physical characteristics remained similar across groups, the biochemical divergence highlights that smoking acts as a potent independent risk factor for kidney damage in hypertensive individuals.

Key words: Hypertension, Smoking, Nicotine, Renal function tests, Non-smoker

INTRODUCTION

Hypertension is highly prevalent, noncommunicable, public health problem with 1.4 billion adults aged 30–79 years worldwide having hypertension and around 7.5 million deaths attributed to hypertension. For many chronic non-communicable diseases related to heart and kidney, hypertension is a major risk factor.

There are many factors predisposing to development of hypertension. These risk factors include age and ethnicity, aging population, mechanical lifestyle, fast paced life in major cities, decreased physical activity and changing food habits. smoking, alcohol, high stress level, obesity etc.

Smoking is known to be one of the leading causes of preventable deaths worldwide, with more than seven million deaths caused by tobacco smoking every year [1]. According to the Indian and Global statistics, currently 130 million people aged 15 and above smoke. [2]. Smoking accounts for one-fifth of all deaths recorded each year, and this number is projected to increase tenfold during the 21st century [3].

There are numerous harmful substances found in tobacco and tobacco smoke. Tobacco contains: Nicotine, Sugars and Acetaldehyde, N-nitrosamine, Benzene, Aromatic amines, 1, 3-Butadiene, Acrolein, Polyaromatics, Flavourings. Nicotine has a dangerous effect on the body by modulating behaviour and dependence resulting in addiction and subsequent repeated exposure to toxins found in tobacco and tobacco smoke.Smoking increases the risk of various chronic diseases including cancer, cardiovascular disease, and respiratory disease, chronic renal diseases [4]. Smoking slows the blood flow to important organs like the kidneys and can make kidney disease worse. The relationship of cigarette smoking and hypertension with the kidney and blood vessels has been extensively studied [5].

Hypertension has long been associated with changes in renal structure and function. In the same way, tobacco usage is associated with changes in the renal microvasculature [6]. Smoking is a primary risk factor for renal artery disease, in which blockages form in the renal arteries. These blockages, when severe and if left untreated, can cause dangerously high blood pressure and kidney failure. A large number of studies have shown that the nicotine and carbon monoxide present in the cigarette smoke causes functional and initially transient damage, primarily to the endothelium [7].

Smoking induces vasoconstriction by activating the sympathetic nervous system, resulting in elevated blood pressure and a decrease in glomerular filtration rate and filtration pressure. It also contributes to the thickening of renal arterioles. Nicotine, a key component of cigarettes, acts as an adrenergic agonist, enhancing both local and systemic catecholamine release and potentially stimulating vasopressin secretion. Tabaco smoking further causes microalbuminuria initially and then its progression to macro albuminuria. There is evidence that the combination of cigarette smoking and hypertension exponentially increases the risk of renal disease [8]. Most epidemiological studies on smoking and blood pressure have been conducted in the general population, while only a few have focused on hypertensive patients, who may exhibit a different pattern in the relationship between smoking and blood pressure [4].

This study aims to investigate the relationship between cigarette smoking in hypertensive patient and kidney functions.

MATERIALS AND METHOD

Study design: This Observational, Cross – Sectional Study was carried out in the Department of Physiology and Department of Medicine MGM medical college and Hospital, Kamothe, MGMIHS Navi Mumbai.

Study population and Sample Size: The Hypertensive patients reporting to Medicine Department, MGM hospital, Navi Mumbai were considered as study population.

The required sample size for the study was determined by using G*Power software.

Total sample size was 110 patients, which was divided into two groups as smoker group and non-smoker group with 55 participants each.

Selection of criteria

The hypertensive patients with history of controlled hypertension for less than 5 years and on stable medication for 1year in the age group of 30-70 years of age both smoker and non-smokers were eligible, hence included in the study.

Patient with uncontrolled high blood pressure with complications, any type of renal diseases, and those not willing to give informed consent were excluded from the study.

Consent, Confidentiality and Ethical Considerations:

Approval by institutional ethics committee was obtained (IEC Approval NO.-N-EC/2022/SC/01/05-) prior to the start of the study.

The participants were given information sheet and explained to the patient in his/her understandable language about confidentiality of their identity and recorded values. Written informed consent was obtained from the participant.

METHODOLOGY

The total of 110 hypertensive patients who fulfilled the required inclusion criteria and volunteered were then called for data collection.

The demographic parameters like age, gender, height, weight, BMI, radial pulse and blood pressure were recorded and clinical examination of patients was carried out. The patients' history of hypertension, its duration, medication, detailed history of smoking was recorded. Participants were divided into two groups depending on the smoking history as Smokers group and Non-smokers group. Blood and urine samples were collected from the patients for Renal Function Test. The tests were done by autoanalyzer (Em 360-Transasia) in the central laboratory of the hospital. The serum creatinine estimation was done by creatinine enzymatic method using creatinase and sacrosine oxidase enzyme kits, The serum urea concentration is estimated by urease GLDH method using Erba diagnostic reagent kits and urine albumin using urine dipsticks. The data of renal function parameters -Serum urea, serum uric acid and serum creatinine levels and urine albumin were collected from patient's report.

Statistical Analysis

Statistical Analysis was done using SPSS version 16. Microsoft excel sheet was used for data compilation. The data was expressed in terms of mean, standard deviation. Independent t-test was used to compare the means of two groups - smokers and non-smoker group. The p value of <0.05 was considered as statistically significant.

RESULTS

Total of 110 patient's data was used for final data analysis. It was divided into two groups depending on the smoking history with 55 in smoker group and 55 in nonsmoker group.

Non-Smoker Group

Table 1. Total of 55 participants with 13 males and 42 females. The baseline characters of non-smokers group show mean age of the participants as 59.13 years, mean height 153.75 cms. Most participants were overweight with mean weight 57.25 Kg, and mean BMI 24.20. The majority of participants were having controlled hypertension with mean systolic BP 150.25 mm of Hg, mean diastolic BP 88.36 mm of Hg. and mean Haemoglobin 9.72 gm%.

The renal function parameters in nonsmoker group were summarized in Table no.2.The majority were showing higher Serum urea than normal (mean Serum Urea 44.08 mg/dL), but Serum Creatinine and Serum uric acid were with in normal limit (mean Serum Creatinine 0.91 mg/dL, mean Serum

Uric acid 5.39 mg/dL). They all were not having albuminuria.

Table 1: Baseline characteristics in non-smokers

Non-smoker		
Parameters	**Mean**	**Std Deviation**
Number	55	
Male	13	
Female	42	
Age (Years)	59.13	13.66
Height (cms)	153.75	3.57
Weight (Kg)	57.25	10.11
BMI	24.20	4.05
SBP (mmHg)	150.25	12.34
DBP (mmHg)	88.36	5.96
Hemoglobin (Gm %)	9.72	2.28

Table 1 show Baseline characteristics of nonsmoker group with mean age 59.12 years, mean height 153.75 cms, mean weight 57.25 Kg, mean BMI 24.2, mean systolic BP 150.25 mm of Hg, mean diastolic BP 88.36 mm of Hg and mean Hemoglobin 9.72 gm%.

Table 2: Renal profile in non-smokers

Non-smoker		
Parameters	**Mean**	**Std Deviation**
Serum Urea (mg/dL)	44.08	12.36
Serum Creatinine (mg/dL)	0.91	0.16
Serum Uric acid (mg/dL)	5.39	0.38
Urine Albumin (Grade)	Grade-0 (Nil)	

Table 2 shows renal function parameters in nonsmoker group with mean Serum Urea 44.08 mg/dL, mean Serum Creatinine 0.91 mg/dL, mean Serum Uric acid 5.39 mg/dL and mean Urine Albumin nil.

Smoker Group

The demographic and baseline characteristics of the smoker group participants are summarized in Table 3. Total 55 participants where only one female and other 54 were males. The baseline characters of non-smokers group show mean age of the participants as 61.71 years, mean height 155.45 cms. Most participants were overweight with mean weight 58.51 Kg, and mean BMI 24.21. The majority of participants were having controlled hypertension with mean systolic BP 156.87 mm of Hg, mean diastolic BP 90.98 mm of Hg. And mean haemoglobin 9.78 gm%.

The renal function parameters in nonsmoker group were summarized in Table no.4.The majority were showing much higher Serum urea than normal (mean Serum Urea 72.41mg/dL). In most of the participants the Serum Creatinine was at higher side of the normal range and Serum uric acid was with in normal limit (mean Serum Creatinine 1.25 mg/dL, mean Serum Uric acid 5.42 mg/dL). They all were having albuminuria with grade 3(+++).

Table 3 show Baseline characteristics of smoker group with mean age 61.71years, mean height 155.45 cms, mean weight 58.51 Kg, mean BMI 24.21, mean systolic BP 156.87 mm of Hg, mean diastolic BP 90.98mm of Hg and mean Hemoglobin 9.78 gm%.

Table 3: Baseline characteristics in Smokers

	Smoker	
Parameters	**Mean**	**Std Deviation**
Number	55	
Male	54	
Female	1	
Age (Years)	61.71	12.36
Height (cms)	155.45	3.52
Weight (Kg)	58.51	11.26
BMI	24.21	4.59
SBP (mmHg)	156.87	13.45
DBP (mmHg)	90.98	6.18
Hemoglobin (Gm %)	9.78	2.28

Table 4: Renal profile in Smokers

	Smoker	
Parameters	**Mean**	**Std Deviation**
Serum Urea (mg/dL)	72.41	25.74
Serum Creatinine (mg/dL)	1.25	1.25
Serum Uric acid (mg/dL)	5.42	0.58
Urine Albumin (Grade)	Grade 3 (+++)	

Table 4 shows renal function parameters in smoker group with mean Serum Urea 72.41mg/dL, mean Serum Creatinine 1.25 mg/dL, mean Serum Uric acid 5.42 mg/dL and mean Urine Albumin grade 3.

Smoking details of smoker group:

The data presented in Table 5 shows details of smoking data of smoking group. Majority of the participants were smoking more 25-30 years with mean of 29 years. They were smoking 20-30 cigarettes per day with mean of 22. Almost 75% were smoking cigarettes and remaining 25% were smoking other products. Almost 70% participants were continuing with smoking habit, only 32% had quite the smoking. 72% participants agreed that smoking was associated with stressful situations. 38% participants were also using tobacco chewing.

Table 5: Smoking details

Parameters		**Value**
Past history of Smoking in years		29.5 ± 10.3 (median =29)
Daily Smoking Frequency		22.4 ± 9.6 (median =23)
Smoking Type	Cigarette/	41 (74.6%)
	Bidi	12 (21.8%)
	Pipe	1 (1.8%)
	Hukkah	1 (1.8%)
Smoking till today (Till date)	Yes	38 (69.09 %)
	No	17 (30.01 %)
Smoking Cessation \Quit	Yes	18 (32.73%)
	No	37 (67.27 %)
Smoking during stressful condition	Yes	40 (72.73 %)
	No	15 (27.27 %)
Other method of Tobacco consumption (Tobacco chewing)	Yes	21 (38.18 %)
	No	34 (61.82%)

Table 5 gives detailed information of smoking history in smokers group in percentage distribution, including duration of smoking, frequency of smoking, type of smoking, smoking cessation and other method of tobacco consumption.

Comparison of between Smokers and Non- smokers

The comparisons of means of baseline characteristics between smokers and nonsmokers' groups was presented in table no.6. There are no statistically significant differences between the baseline characteristics of two groups except in systolic BP and diastolic BP. The systolic BP higher in smoker group (Mean-156.87mmHg) compared to nonsmoker group (Mean-150.25mm Hg) which is statistically significant with p value 0.0083. The diastolic BP higher in smoker group (Mean-90.98 mmHg) compared to nonsmoker group (Mean-88.36 mm Hg) which is statistically significant with p value 0.02578.

Comparison of Renal function parameters between Smokers and Non- smokers' group was showed in table 7. The mean serum urea in smoker group is 72.40 mg/dl and nonsmoker group is 44.08mg/dl, the mean difference is statistically highly significant with p value 0.00001. The mean serum Creatinine in smoker group is 1.25 mg/dl and nonsmoker group is 0.91 mg/dl, the mean difference is statistically highly significant with p value 0.00001. The mean serum Uric acid in smoker group is 5.42mg/dl and nonsmoker group is 5.39 mg/dl, the mean difference is statistically not significant with p value 0.7369. The urine albumin was present in smoker group with grade 3 and no urine albumin in nonsmoker group.

Table 6: Comparison of baseline characteristics between Smokers and Non- smokers

	Non-smoker		Smoker			
Parameters	**Mean**	**Std Deviation**	**Mean**	**Std Deviation**	**t value**	**p value**
Number	55		55			
Male	13		54			
Female	42		1			
Age (Years)	59.13	13.66	61.71	12.36	-1.04	0.30084
Height (cms)	153.75	3.57	155.45	3.52	-2.53	0.01287
Weight (Kg)	57.25	10.11	58.51	11.26	-0.61	0.54
BMI	24.20	4.05	24.21	4.59	-0.02	0.9835
SBP (mmHg)	150.25	12.34	156.87	13.45	-2.69	0.0083*
DBP (mmHg)	88.36	5.96	90.98	6.18	-2.26	0.02578*
Hemoglobin (Gm %)	9.72	2.28	9.78	2.28	-0.14	0.89252

Table 6 shows comparisons of means of baseline characteristics between smokers and nonsmokers' groups. There is no statistically significant (p value <0.05) between the baseline characteristics of two groups except systolic BP and diastolic BP.

Table 7: Comparison of Renal profile between Smokers and Non- smokers

	Non-smoker		Smoker			
Parameters	**Mean**	**Std Deviation**	**Mean**	**Std Deviation**	**t value**	**p value**
Serum Urea (mg/dL)	44.08	12.36	72.41	25.74	-7.36	0.00001*
Serum Creatinine (mg/dL)	0.91	0.16	1.25	1.25	-6.34	0.00001*
Serum Uric acid (mg/dL)	5.39	0.38	5.42	0.58	-0.34	0.7369
Urine Albumin (Grade)	Grade-0(Nil)		Grade 3 (+++)			

Comparison of Renal function parameters between Smokers and Non- smokers' group was showed in table 7. The statistically highly significant difference was observed in mean serum urea and mean serum Creatinine with p value less than 0.01. the statistically non-significant difference observed in mean serum Uric acid, with smokers' group having higher values.

DISCUSSION

The observational, cross – sectional study was done in which data of the hypertensive patients from Medicine Department of MGM hospital, Navi Mumbai, was

collected. Total of 110 patient's data were included in this study. After collecting their demographic data patients were divided into two groups as smokers and non-smokers, depending on their history of smoking. In each group, there were 55 participants.

The means of baseline characteristics of the groups were as follows.

In the non-smoker group, the mean age was 59.13 years, mean height was 153.75cms, the mean weight was 57.25 Kg, mean BMI was 24.20 $Kg/m^{2,}$ mean systolic BP was 150.25 mmHg, mean diastolic was BP 88.36 mmHg and mean Haemoglobin was 9.72 gm%.

In smoker group, the mean age was 61.71 years, mean was height 155.45cms, mean weight was 58.51 Kg, mean was BMI 24.21 Kg/m2, mean systolic BP was 156.87 mmHg, mean diastolic BP was 90.98mmHg and mean Haemoglobin was 9.78 gm%.

There is no statistically significant (p value <0.05) between the baseline characteristics of two groups except systolic BP and diastolic BP. The systolic BP higher in smoker group (Mean-156.87mmHg) compared to non-smoker group (Mean-150.25mm Hg) which is statistically significant (p value 0.0083). The diastolic BP higher in smoker group (Mean-90.98 mmHg) compared to non-smoker group (Mean-88.36 mm Hg) which is statistically significant (p value 0.0257).

Samuel J. Mann, MD; Gary D. James, PhD; Ruby S. Wang; et al compared ambulatory blood pressures of age, sex, and race matched 59 untreated hypertensive smokers with 118 non-smoking hypertensive patients. They found that awake ambulatory systolic blood pressure was significantly higher in the smokers and among patients over the age of 50 years [9].

Yutaka Takashima, Masao Yoshida, Mamoru Ishikawa et al. conducted a study based on annual health check-up data of one-year duration for 611 middle and old-aged Japanese residents. After adjusting for age, gender, body mass index score, they found that the proportion of hypertensive and the mean systolic and diastolic blood pressure were the highest in the smokers who smoked more than 25 cigarettes per day [10].

Our study also had similar results as smoker group mean age was higher and systolic BP and diastolic BP were significantly higher compared to non-smoker group. Smoking is a potent modifiable risk factor for cardiovascular diseases. The cigarette smoking produces an acute rise in the BP [11,12]. Acute smoking increases arterial stiffness in both smokers and non-smokers [13]. Many studies have consistently shown that acute cigarette smoking decreases arterial compliance in the both large elastic and medium size muscular arteries and induces degenerative changes or remodelling of the small arteries leading to increased BP [7].

The Comparison of Renal function parameters between Smokers and Non-smokers' group in our study shows following results. The mean serum urea in smoker group is 72.41 mg/dl and non-smoker group is 44.08mg/dl, the mean difference is statistically highly significant with p value<0.001. (Table no.7) The mean serum Creatinine in smoker group is 1.25 mg/dl and non-smoker group is 0.91 mg/dl, the mean difference is statistically highly significant with p value<0.001(Table no.7) The mean serum Uric acid in smoker group is 5.42mg/dl and non-smoker group is 5.39 mg/dl, the mean difference is statistically not significant with p value more than 0.05(Table no.7)

Hoda A Eid1, Eman M Moazenet al studied early effects of smoking on kidney function by investigating serum kidney function tests in 280 participants, of which 140 were non-smokers and 140 were smokers. They found that serum urea, serum creatinine, and urinary albumin levels were significantly higher in the smokers' group compared to the non-smokers [14].

The study done by Bleyer et al, in which they analysed the data obtained in 4142 nondiabetic subjects with ages more than 64 years in whom serum creatinine was measured at least 3 years apart. Their

analysis revealed a strong association between the number of cigarettes smoked and an increase in serum creatinine levels [15].

Similar findings were also reported by García et al in their cross-sectional study involving 7516 US adolescents aged 12-17 years. They measured serum creatinine and cotinine. They showed that estimated glomerular filtration rate (eGFR) was highly significantly decreased in heavy smokers; relative to other groups hence concluded that tobacco smoke exposure was associated with decreased eGFR in US adolescents [16].

Our study also showed the similar results as statistically significant higher serum creatinine and serum urea in smoker group compared to non-smoker group. Regarding urine albumin, we found that the mean grade of urine albumin in smoker group is 3and non-smoker group is nil. Yuka Noborisaka et al studied Cigarette smoking, proteinuria and the estimated glomerular filtration rate (eGFR) in 990 middle-aged men working in chemical plant. They found high proteinuria and high eGFR in smokers. In 13.3% of the subjects, proteinuria was associated with subnormal eGFR, out of which 16.7% were smokers and 8.3% were non-smokers [17].

Esther M. Briganti et al., in a cross-sectional study involving 11,247 Australian adults, demonstrated that smoking was significantly associated with proteinuria in individuals with high-normal systolic blood pressure and high-normal 2-hour glucose levels. Lifetime exposure to smoking, rather than the current level of smoking, correlated with a lower estimated glomerular filtration rate and a higher urine protein-creatinine ratio.[18] Many studies have shown that proteinuria or microalbuminuria was higher in smokers than in non-smokers, up to 2 to 3-times higher than in lifelong non-smokers [19-22].

But in our study, we find urine albumin in smoker group and no albumin in non-smokers. The hypertension itself is one of risk factor for microalbuminuria or proteinuria. Serum creatinine is an important biomarker of renal function and serves as a convenient indicator of kidney health. The subjects with higher serum creatinine levels have higher risk of chronic kidney disease development. The microalbuminuria is also earliest ways to detect kidney disease. Microalbuminuria or proteinuria is caused by damage to the filtration membrane of the kidney secondary to hypertension, diabetes mellitus, obesity, smoking status and congenital kidney diseases. Hypertension is the key risk factor of chronic kidney disease [23].

Smoking can increase the risk of chronic kidney disease by promoting a pro-inflammatory state, oxidative stress, a prothrombotic tendency, endothelial dysfunction, glomerulosclerosis, and tubular atrophy. Being a well-established risk factor for numerous diseases, smoking has also been shown to play a significant role in the development and progression of renal disorders [1].

In the present study, other risk factors like age, BMI and hypertension may be involved in influencing the occurrence of kidney damage. A decline in renal function with advancing age has been observed in some individuals, though not in all [15, 24].

The middle aged and elderly subjects are vulnerable to the age-related decline in kidney function. In this study mean age of subject were 61.7 years in smokers' group and 59.12 years in non-smoker group. Lower BMI has previously been associated with higher mortality in patients with chronic kidney disease [25]. Numerous published studies have also identified obesity as a strong risk factor for the development of chronic kidney disease [26].

In our study, as per BMI subjects were overweight (Smoker BMI- 24.21 & Non-smoker BMI- 24.20) and statistically non-significant between two groups.

The rising prevalence of chronic non-communicable diseases in India can be attributed to lifestyle changes and an increase in associated risk factors. The key modifiable risk factors for chronic kidney disease include body mass index (BMI),

hypertension, smoking, diabetes mellitus, and elevated serum creatinine levels. The main non-modifiable risk factors are age, gender, and a family history of kidney disease. The presence of any one of these factors is associated with an increased risk of developing chronic kidney disease.

Limitations of the Study

The data collection was done in cross sectional way on a single day, hence measurements of markers of kidney damage are unlikely to represent true prevalence of chronic kidney disease. The observed relationship between cigarette smoking and kidney damage, hypertension and kidney damage is confounding factor. The presence of heterogeneity across study in terms of classification of smokers and quantifying tobacco exposure, different types of tobacco products and also parameters to define kidney damage, genetic and environment variables may be potential contributors to the observed results.

CONCLUSION

We studied the effect of tobacco smoking on Kidney functions of hypertensive patients. The baseline characteristics like age, height, weight and BMI between smokers and non-smokers groups were similar, with no statistically significant. The mean systolic BP, mean diastolic BP and mean serum urea and mean serum Creatinine were statistically significant higher in smoker group compared to non-smoker group. The mean serum Uric acid and mean grade of urine albumin did show statistically significant difference between smoker and non-smoker group. Thus, we conclude that along with hypertension, smoking is also one of the risk factors for kidney damage.

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