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The Affects of Smoking on Cataract Formation in Turkish Patients

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Authors' contributions

This work was carried out in collaboration between all authors. Authors AK and TKE designed the study, wrote the protocol, and wrote the first draft of the manuscript. Authors TKE, AK and RK managed the literature searches. Statistical analyzes were carried out by NMK. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To investigate whether smoking influences cataract formation age and cataract type in patients who underwent senile cataract surgery.
Study Design: Retrospective cross-sectional.
Place and Duration of Study: The study was conducted in the Department Of Ophthalmology, Ahi Evran Faculty Of Medicine between November 2014 and March 2018.
Methodology: Five hundred eighty-one patients were included, who were operated on for senile cataracts. Age, gender, cataract type, and smoking status of patients were recorded. Congenital,

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traumatic, drug-induced, and uveitic cataracts were excluded from the study. The smoking status of patients was divided into three groups: currently smoking, never smoking, quitted smoking. The smoking load of patients was calculated as packages/year.

Results: Of total of 581 patients, 47.8% (278) were female and 52.2% (303) were male and the mean ages were 66.68 ± 10.68 years and 66.17 ± 9.37 years, respectively. There was an association between gender and smoking status ($p<0.05$). Smoking rate (both currently smoking and quit smoking) was higher among males. The mean age of cataract patients who were smokers was statistically lower than the mean ages of non-smokers and quitters ($p <0.001$). There was a statistical association between cataract type of patients and smoking status ($p=0.0152$). This resulted from a lower incidence of cortical cataracts and higher incidence of posterior subcapsular and nuclear cataracts in smokers. Among these three groups, cortical cataract was the most frequent in the non-smoker group. It was found that smoking increases the posterior subcapsular cataract, but it has less effect on cortical cataract formation.

Conclusion: Smoking causes cataract formation in younger ages and higher posterior subcapsular cataract rate. We suggest that this finding may prevent beginning of smoking and increase the motivation of individuals to quit smoking**.**

Keywords: Cataract; cataract type; cigarette cessation; smoking.

1. INTRODUCTION

At present, the most prevalent cause of treatable blindness is cataract. The data from WHO (World Health Organization) in 2014 indicated that 35% of blindness in the world is resulted from cataracts. According to WHO estimates, 54 million people over 60 years of age will have low vision because of cataracts by 2020 [1]. Although surgical removal is the only available treatment for cataract, identifying the risk factors to take protective measures is also important. Aging is the most important known risk factor for cataracts. The other risk factors are genetic disposition, diabetes, ultraviolet radiation, corticosteroid use, hypoparathyroidism, trauma, and persistent intraocular inflammation [2,3].

One of the factors accused of cataract formations is smoking [4,5]. After prolonged smoking, ocular side effects in addition to systemic diseases and various malignancies caused by chemical ingredients are known so far [6,7]. These ocular side effects shown previously include irritation to the ocular surface, cataract formation, and progression, increased intraocular pressure, vasoconstriction in the ophthalmic artery, decreased ocular perfusion pressure, higher risk, rate, and severity of Grave's ophthalmopathy, formation and progression of age-related macular degeneration [8-11]. As it is a preventable risk factor, the association between smoking and cataracts is important. Avoiding smoking may delay cataract formation and progression, as well as decrease the financial and clinical load needed for cataract surgery considerably.

To our knowledge, there is no study investigating the relationship between smoking and cataract formation in Turkish patients. In this study, it is therefore aimed to investigate whether smoking influence cataract formation age and cataract type in patients who underwent senile cataract surgery.

2. MATERIALS AND METHODS

Five hundred eighty-one patients who were operated on for senile cataracts between November 2014 and March 2018 in Ahi Evran University, Faculty of Medicine, Department of Ophthalmology were evaluated retrospectively. Information about the study was provided to patients and written consent was obtained from all subjects. The age, gender, cataract type, and smoking status of patients were recorded. Use of smoking and alcohol was questioned again by phone calls and missing information was completed. Patients who cannot be reached by phone call or who use alcohol were excluded from the study. Information about the remaining 581 patients were recorded.

All the patients underwent full ophthalmological examination. Patients who have 0.3 or less visual acuity according to the decimal Snellen chart were operated on. Cataract type was recorded by slit lamp examination after pupillary dilatation. The cataract classification was made according to its anatomical location by Brown and Hill [12] and Lens Opacities Classification System III [13] which included nuclear, cortical, and posterior subcapsular cataracts (PSC). Mixed type and

mature cataracts were not included in the study. Congenital, traumatic, drug-induced and uveitic cataracts were excluded from the study.

The smoking status of patients were divided into three groups: currently smoking, never smoked, quitted smoking. The smoking load of patients were calculated as packages/year (grouped as ≤5 packages/year, 6-10 packages/year, 11-20 packages/year, 21-30 packages/year, 31-40 packages/year, ≥41 packages/year).

2.1 Statistical Analysis

The associations between cataract type and smoking status, age, gender, time since quitting, smoking load (packages/year) were investigated. Categorical variables were given as number and percentage, numerical variables were given as mean - standard deviation and as median and minimum-maximum values. Normal distribution of numerical variables were tested by Shapiro – Wilks test and when assumption was validated analysis of one way variance (ANOVA) and independent T tests were used for comparisons between groups and when normal distribution was not validated Mann-Whitney U test were used. When a difference was found among the groups, Bonferroni pair comparison test was used to find out the group that causing the difference. Chi-square test was used to compare categorical variables. All the analysis was conducted by IBM SPSS 22.0 package program (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.), and $p<0.05$ was accepted as statistical significance for all analysis.

3. RESULTS

The demographical data, cataract types, and smoking status of the patients were summarized in Table 1 and Table 2.

There was an association between the gender and the smoking status ($p<0.05$). The smoking rate (both currently smoking and quit smoking) was higher in males and female ratio was higher in the non-smoker group (Table 3).

The mean age of smokers was lower than the mean age of non-smokers and quitters and this was statistically significant ($p <0.001$) (Table 4).

The associations between smoking status and Diabetes Mellitus (DM), and Hypertension (HT) were also investigated. There was no statistical difference between the smoking status and cataract type in patients with DM ($p=0.807$). Similarly, there was no statistical difference between the smoking status and cataract type in patients with and without HT [respectively $p=0.192$ (smoking- cataract type comparison in patients with HT) / and $p=0.067$ (smoking-cataract type comparison in patients without HT)].

Table 1. Demographical Features

Numerical Variables	**n**	**Mean ± SD**
Age	581	66.49 ± 9.67
Female - Age	278	66.68 ± 10.68
Male - Age	303	66.17 ± 9.37
Categorical Variables Gender	**n**	**%**
Male	303	52.2
Female	278	47.8
HT	239	41.1
DM	173	29.8

n; number, SD; Standard Deviation, DM; Diabetes Mellitus, HT; Hypertension

There was a statistically significant difference between the cataract type and the smoking status of patients ($p=0.0152$). This difference was due to less frequent cortical cataract and more frequent PSC and nuclear cataracts in currently smoking group. Additionally, the frequency of cortical and PSC cataract type in the quitter group was between the frequency of current smokers and nonsmokers (Table 5). Almost half of the cataracts in current smoker group was PSC cataract and cortical cataract was the least frequent type. In the quitter group, nuclear and PSC frequency was 41%. The frequency of PSC and nuclear cataract types were similar in the nonsmoker group. Among the three groups cortical cataract was the most prevalent in the non-smoker group. With smoking, the PSC frequency was increased and it is found that cortical cataract was less affected by smoking (Table 5).

When the association between the gender and cataract type was evaluated within smoking status, the frequencies of nuclear and PSC type was more prevalent in smoking males compared to smoking females ($p<0.05$).

Table 2. Smoking status and cataract types

		n	%
Smoking Load (packages/years)	**≤5**	13	5
	6-10	24	9.2
	11-20	63	24
	21-30	50	19.1
	31-40	37	14.1
	≥41	75	28.6
Time since quitting smoking (years)	**≤1**	4	2.5
	1-5	24	15.2
	6-10	46	29.1
	11-15	20	12.7
	≥16	64	40.5
Smoking Status	**Never smoked**	318	54.7
	Currently Smoking	106	18.2
	Quitted Smoking	157	27.1
Cataract Type	**Nuclear**	228	39.2
	Cortical	114	19.6
	PSC	239	41.1

n; number, SD; Standard Deviation, PSC; Posterior Subcapsular Cataract.

Table 3. Association between smoking and gender

Gender	Never Smoked	Currently Smoking	Quitted Smoking	p
Female	237(85.3%)	20 (7.2%)	21 (7.6%)	
Male	81 (26.7%)	86(28.4%)	136 (44.9%)	<0.001

Table 4. The mean ages according to smoking status, and p value

Smoking Status	n	Mean ± SD (years)	p
Never Smoked	318	67.82± 9.81	<0.001
Currently Smoking	106	61.39 ± 9.36	
Quitted smoking	157	67.29 ± 8.47	

n; number, SD; Standard Deviation.

Table 5. The association between cataract type and smoking (Pearson Chi-Square:12.302; p-value:0.015)

Cataract Type	Never Smoked (n,%)	Currently Smoking (n,%)	Quitted smoking(n,%)	Total (n,%)
Nuclear	119 (37.4)	44 (41.5)	65 (41.4)	228(39.3)
Cortical	77 (24.2)	10 (9.4)	27 (17.2)	114 (19.6)
PSC	122 (38.4)	52 (49.1)	65 (41.4)	239 (41.1)
Total	318 (100)	106 (100)	157 (100)	581 (100)

n; number, PSC; Posterior Subcapsular Cataract.

The association between the smoking load of patients (packages year) and cataract type was also analyzed. According to the results, there was no statistically significant association between the smoking load and cataract type (p=0.157).

4. DISCUSSION

Cigarette smoke is a mixture of thousands of chemicals including the particles such as nicotine, volatile chemicals such as formaldehyde, and gases such as carbon monoxide [6]. In addition to reported side effects of smoking on almost all layers of the eye [8-11], many molecular mechanisms were suggested for enhancing cataract formations [14-23]. One of those mechanisms is impairment of alpha-crystallin protein structure which is a major protein in the lens. In Alpha crystalline proteins there are two sub-units as Alpha-A and Alpha-B [14]. Alpha crystalline has

a chaperon function and it has a significant role in lens transparency. Alpha crystalline prevents protein aggregates which may cause light scattering by binding denaturated proteins with is chaperon feature [15]. However, chaperone-like activity of alpha crystalline may be disturbed or lost by various genetical and environmental factors, aging, and some clinical conditions. Ultimately, the lens loses its transparency [15]. In a recent experimental study, p-parabenzoquinone was detected in porcine lenses and lenses obtained from smoking humans. It was shown that p-parabenzoquinone caused cataracts by disturbing the structure of alpha crystalline [16].
The epithelial cells are the first line cells in the lens which are vulnerable to many damages causing cataracts because of their superficial localization. These cells are well-equipped to protect the lens from harmful factors and metabolically they are quite active. Therefore, the epithelial cells were investigated by many researchers for cataract pathogenesis related to age and disease [17]. It is suggested that oxidative stress may trigger cataract formation by causing changes in lens epithelium [18]. Smoking may cause additional oxidative stress by indirectly decreasing antioxidant molecules like ascorbic acid and nicotinamide [19,20]. In addition, heavy metals in cigarette like lead and cadmium may cause oxidative stress by depletion of glutathione and thiol pool and may disturb the antioxidant protections system. A previous study reported that cadmium caused apoptosis in human lens epithelial cells [18-23]. In another study, hyperplasia, hypertrophy, and stratification of lens epithelial cells were observed in histopathological examination of rat lenses which exposed to cigarette smoking 2 hours a day for 60 days [24]. Additionally, zinc level was decreased, and iron and copper levels were increased in lenses. It was thought that oxygen radicals produced by Fenton's reaction of that increased metal load and increased oxidative stress may cause lens damage [24]. In our study, currently smokers and quitters had cataracts at younger ages compared to nonsmoker group. We suggest that it might be caused by earlier aging of the lens because of the reasons discussed above.

Many studies were conducted previously about the effect of smoking on cataract formation and cataract types. Among those studies, some reported no effect on cataract type while the others reported the opposite. Many researchers reported that smoking had a positive association with nuclear and PSC cataract formation while it had no effect on cortical cataract formation [4,5,25-28]. In Blue Mountains Study including 3645 people, the effect of smoking and alcohol use on cataract were investigated and nuclear cataract prevalence was found to be higher than PSC prevalence in smokers and alcohol users. It is reported that the cataract formation risk was much higher in people who both smoke and use alcohol [25]. Prospective studies including large number of cases like Physicians Health Study (17824 cases) [26] and Nurses Health Study and Health Professionals Follow up Study (124690 cases) [27] reported that smoking is a risk factor for PSC cataract. Similarly, in our study, PSC rate was significantly higher in smokers compared to nonsmokers.

Many studies showed that cataract risk decreased after quitting smoking [29-31]. One of the most extended information about the cataract formation in people who quit smoking was in 2 studies of Lindblad et al. [29,30]. In this prospective study including 34595 females, when compared to nonsmokers, 10 years after quitting smoking in people who smoked 6-10 cigarettes a day and 20 years after quitting smoking in people who smoked 10-15 cigarettes a day, there was no statistical difference for cataract surgery need. For smokers who smoke 15 cigarettes a day or more, after quitting smoking, the cataract formation risk continued even the risk decreased [30]. Likewise, the decreased PSC rate in quitters in our study showed that cataract risk may decrease after quitting smoking. In a prospective study with 5 years follow up, of 17824 doctors between 45 and 84 years of age, 33% were smokers, 39% were quitters and 51% were nonsmokers. It is reported that the nuclear and PSC rate was increased in people who smoke 20 or more cigarettes a day. They reported that while nuclear cataract formation risk decreases in people who quit smoking, PSC rate did not change [26]. In our study, while a significant association between smoking and PSC formation was found, there was no effect on cortical cataract formation. In the people who quit smoking, cataract formation age was higher and PSC rate was decreased.

5. CONCLUSION

The pathogenesis of cataract formation is influenced by many factors including genetic

and environmental factors. We are aware that this is the first study investigating smoking affects on cataract formation in Turkish patients. In this study, it was shown that smoking caused higher PSC rates and cataract surgery in earlier age. As it is reported that 10-year delay in cataract formation decreased the cataract surgery rate and related costs by 50% [32], we suggest that more critical public health care policies should be raised to prevent and quit smoking.

ETHICAL APPROVAL

The study protocol was approved by the Ahi Evran University Faculty of Medicine Clinical Research Ethics Committee (Ethical approval number: 2018-07/69).

CONSENT

As per international standards or university standards, patient(s) written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

The authors have declared that no competing interests exist.

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