Original Article

Changes in Ocular Surface and Precorneal Tear Film in Tobacco Smokers

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ABSTRACT

Purpose: To determine the changes in "ocular surface" and "pre-corneal tear film" in tobacco smokers.

Study Design: Cross sectional, comparative.

Place and Duration of Study: Holy Family Hospital, Rawalpindi Medical University, Rawalpindi, Pakistan from February 2022 to May 2022.

Methods: Eighty four patients (42 smokers and 42 non-smokers) were selected for ocular evaluation. "Ocular surface" and "pre-corneal tear film" were assessed by "tear film break up time (TBUT)", "Schirmer test", "corneal punctate staining" and "corneal/conjunctival sensitivity" in both smokers and non-smokers. Chi square test and unpaired t-test were applied and $p \leq 0.05$ was taken as significant.

Results: Mean age of participants was 36.07 ± 5.75 years. There were 76.2% males and 23.8% females. In terms of age and gender, there was no statistically significant difference between smokers and non-smokers. In terms of TBUT ($p = 0.000$), corneal punctate staining ($p = 0.000$) and corneal/conjunctival sensitivity ($p = 0.000$) values were significantly lower in smokers as compared to non-smokers while in terms of "Schirmer test" there was no statistically significant difference between smokers and non-smokers (p-value of 0.827).

Conclusion: Use of cigarettes results in multiple adverse effects in the "ocular surface" and "pre-corneal tear film" including unstable tear film, dry eyes, poor sensitivity of cornea as well as the conjunctiva making their eyes more prone to damage and disease.

Key Words: Cornea, Conjunctiva, Tobacco, Ocular surface, Pre-corneal tear film, Dry eyes.

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INTRODUCTION

Tobacco smoking has been linked to a variety of fatal diseases and disorders, including "chronic obstructive pulmonary disease (COPD)"[1], "coronary artery disease (CAD)"[2], cancers affecting every organ system [3] and poor reproductive health.[4] Numerous conditions affecting eyes have been found to be associated with smoking. Because toxic compounds can injure ocular tissues through "ischemic" and "oxidative" effects, it can lead to certain disorders of eyes such as dry eyes, cataract, ischemia, age-related macular degeneration, etc.[5,6] Additionally, passive smoking may harm the eyes as well. In fact, the eye is especially vulnerable to air contaminants because of its exposure to the atmosphere.[7] In fact it is one of the most common environmental pollutant that eyes are exposed to both indoors as well as outdoors.[8] The use of electronic cigarettes, commonly known as "e-cigarettes," which contain a considerable quantity of free radicals despite having less pollutants than tobacco cigarettes, has increased in recent years which can also lead to ocular

irritation.[9,10] The amount of free radicals varies according to the proportion of various components, chemicals, temperature of the device and the flavors used.[11,12]

The tear film is composed of three layers: a "mucous layer" that is in touch with the corneal epithelium, an intermediate "aqueous layer" that makes up the major volume of tears (produced by the lacrimal glands) and an external "lipid layer" (made by meibomian glands) that prevents tears from evaporating.[13] Smoking actually causes damage to one or all of these layers leading to instability of pre-corneal tear film and subsequent damage to the ocular surface measured by various tests, particularly "tear film break up time (TBUT)".[14] However, there are studies that show no difference between the smokers and non-smokers in terms of stability of pre-cornel tear film.[15] Owing to these conflicting opinion in the literature regarding the effects and changes that smoking exerts on the "ocular surface" and "pre-corneal tear film" we aimed to conduct this study to find out the answer to this query in our population.

METHODS

This cross sectional study was conducted at "The Department of Ophthalmology Holy Family Hospital, Rawalpindi Medical University, Rawalpindi, Pakistan" from February 2022 to May 2022 after obtaining approval from the ethical committee of the institution. Sample size of 84 (42 smokers and 42 non-smokers) was calculated using WHO sample size calculator by assuming level of significance 10%, power80%, and anticipated mean in the two populations with their standard deviations of 11.9 ± 5.8 and 14.9 ± 5.5[16] using following formula:

$$n = \frac{2\sigma^2(z_{1-\alpha/2} + z_{1-\beta})^2}{(\mu_1 - \mu_2)^2}$$

Age of the patients ranged from 28 to 50 years. Either male or female gender with half of them being smokers while the other half being non-smokers were included. Patients were chosen to participate in this study using a quota sampling technique. Patients who had history of previous eye surgery, who were regular users of contact lenses, used any other recreational drugs, history of rheumatology/autoimmune disease affecting the eyes, allergic/infectious/congenital eye disease, patients who were regular users of artificial tears eye drops and diabetics were excluded from the study. Written consent forms were signed from each patient. Baseline demographic information, such as age, gender, duration since they were smoking and daily cigarette intake was recorded. To assess the changes in "ocular surface" and "pre-corneal tear film" following tests were applied in all the study participants i.e. Tear film breakup time (TBUT), Schirmer test, Superficial Corneal punctate staining, Corneal/Conjunctival sensitivity.

Data was analyzed by using SPSS 20. Quantitative data was represented using mean with standard deviation and the median (IQR). Qualitative data was represented by using percentage and frequency. Chi square test (for qualitative variables) and unpaired t-test (for quantitative variables) were applied and $p \leq 0.05$ was taken as significant.

RESULTS

In 84 patients, mean age was 36.07 ± 5.75 years, median age was 36 years while mode age was 31 years and amongst these participants 76.2% (64/84) were male while 23.8% (20/84) were female. Comparison of baseline characteristics of smokers versus non-smokers is demonstrated in table 1.

Table 1: *Baseline characteristics of Smokers vs Non-Smokers.*

Sr. No.	Characteristics	Smokers	Non-Smokers	p-value
1.	Mean Age	34.93 ± 5.94 years	37.21 ± 5.38 years	0.068
2.	Gender - Male - Female	80.9% (34/42) 19.1% (8/42)	71.4% (30/42) 28.6% (12/42)	0.306
3.	Duration of smoking	7.38 ± 3.08 years	/	———
4.	Number of cigarettes per day	10.33 ± 5.75 years	/	———

Table 2: *Comparison of Tests for "Ocular Surface" and "Pre-corneal Tear Film" between Smokers and Non-smokers.*

Test	Smokers	Non-Smokers	p-value
TBUT (seconds)	7.74 ± 1.36	12.93 ± 3.31	0.000
Schirmer Test (mm)	21.24 ± 1.96	21.33 ± 2.02	0.827
Presence of Punctate Staining (%)	64.28%	11.90%	0.000
Corneal Sensitivity (mm)	44.19 ± 2.79	53.55 ± 4.05	0.000
Conjunctival Sensitivity (mm)	30.17 ± 1.61	38.88 ± 2.35	0.000

Comparison of the "TBUT", "Schirmer test", "corneal punctate staining" and "corneal/conjunctival sensitivity" between smokers and non-smokers is elaborated in table 2.

DISCUSSION

Smoking irritates the ocular surface and is linked to damage of corneal epithelial cells that may result in "dry eye disease (DED)".[17] Smoking may be a risk factor for "dry eye disease (DED)," according to the "Epidemiology Report subcommittee of the TFOS DEWS II," yet there is conflicting evidence to support this claim.[18]

The "pre-corneal tear film" is the initial refractive surface of the eye, it is a fluid layer that covers the surface of the eye externally and plays a crucial function in eye health and vision.[19] Previously some studies have shown a significant effect of smoking on the "ocular surface" as well as "pre-corneal tear film" while other studies have shown no such significant effect of smoking on the eyes.[20,21]

In our study, there was no statistically significant difference between the two groups of study participants (p-values of 0.068 and 0.306, respectively). TBUT was less in smokers as compared to non-smokers ($p = 0.000$), "Schirmer test" showed statistically insignificant difference between the two groups ($p = 0.827$). In terms of presence of "corneal punctate staining" we found that its frequency was much higher in the smokers as compared to non-smokers ($p = 0.000$). "Corneal/conjunctival sensitivity" among smokers was much lower than the non-smokers (p-values of 0.000).

In previous studies, Thomas et al.,[22]found that there was a statistically significant difference in all the parameters of ocular surface and pre-corneal tear film (except for Schirmer test) between smokers and non-smokers. Similarly, Latif & Naroo[23] reported that TBUT was significantly reduced in smokers as compared to non-smokers ($p < 0.001$). Similarly, in another study conducted by Bhutia et al.[24] TBUT was significantly lower in smokers ($p < 0001$), the "Schirmer test" values, contrary to results of our study, were also significantly lower in smokers ($p = 0.0127$).

Our study had the limitations of only including patients from one institution, having a short follow-up period and a small sample size. Relation of dry eye to the amount of smoking was not considered.

CONCLUSION

Conclusion of this study is that because smoking causes various negative effects on the "ocular surface" and the "pre-corneal tear film", such as an unstable tear film, dry eyes and poor sensitivity of the cornea and the conjunctiva, a smoker's eyes are more susceptible to damage and disease.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board **(197/IREF/RMU/2022).**

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Authors' Designation and Contribution

Hafiz Muhammad Jahanzaib; Medical Officer: *Concepts, Design, Literature Search, Data Acquisition, Data Analysis, Statistical Analysis.*

Amina Khalid; PGR: *Design, Literature Search, Data Acquisition, Statistical Analysis, Manuscript Preparation, Manuscript Review.*

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