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Ocular Surface Changes among Smokers

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: The ocular surface has been defined as the parts of the eye that are exposed 40directly to the external environment (conjunctiva, cornea, limbus, and the overlying tear fil m). The purpose of this study was to determine the changes in the ocular surface among smokers.
Methods: This study included 100 subjects from both sexes, age ≥ 18 years, current smoker (a person who has smoked more than 100 cigarettes in his lifetime and continues to do so) and all types of smoking. patients were classified into two groups: smokers (current smokers) (55 cases) and non-smokers (45 cases) who have never smoked and did not have smokers in their first-degree relatives to rule out the effect of passive smoking. All patients were subjected to, acuity of vision measurement, investigation with a slit lamp and special tests (schirmer 2 test, time required for tear breakup, lower tear meniscus height measurement and staining of the ocular surface).
Results: (Ocular Surface Disease Index) OSDI score was significantly different between non-smokers and smokers with P value 0.01. Schirmer 2 test values were significantly decreased in smokers more than non-smokers with P value <0.001. TBUT was significantly lower in smokers more than non-smokers with P value <0.001. T.M height was significantly lower in smokers more than non-smokers. Conjunctival staining was significantly higher in smokers than non-smokers with

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P value <0.001 and there was significant increase in punctate corneal staining in smokers than in non-smokers with P value <0.001. `1234567890-.
Conclusions: Smoking influences the secretion and the tear film's stability; corneal and conjunctival staining was shown to be more prevalent in smokers. Also smoking generates symptoms of eye irritation, smokers are more prone to have dry eyes, and the degree of dry eye is greater in smokers than in non-smokers. Additionally, the severity of symptoms of dry eyes increased with increasing the amount of smoking.

Keywords: Ocular surface; smokers; OSDI score.

1. INTRODUCTION

The ocular surface has been defined as the parts of the eye that are exposed directly to the external environment (conjunctiva, cornea, limbus, and the tear film that is affixed to the surface). The eye's surface, together with the glands lacrimal, glands meibomian, eye lids and related sensory and motor nerves connecting them, form the lacrimal functional unit (LFU) which is a consolidated unit responsible for maintenance of the corneal transparency, ocular surface health and optical clarity [1].

The tear film is the LFU's most active structure, and its production and circulation are critical for maintenance of homeostasis of the ocular surface. Traditionally, the tear film is shown to comprise three layers: lipid , mucous and aqueous [2]. There are no physical borders between these layers, and any of them can become dysfunctional, resulting in dry eye [3].

Dry eye is a complex illness affecting the ocular surface and tears which manifests as symptoms of itching, redness, light hypersensitivity, blurred vision, ocular discomfort, foreign body sensation and redness [3].

Numerous risk factors are related with dry eye like environmental conditions, lifestyle, drug use history, age, gender, and systemic disorders [4]. It is one of the most frequently encountered causes for a patient to consult an eye care specialist [5].

Tobacco use is one of the most pervasive addictive behaviours, resulting in a variety of detrimental outcomes, including cardiovascular, respiratory, and malignant disorders [6].

Smoking seems to have a detrimental effect on the eyes. Cigarette smoking has been linked to a variety of ophthalmological problems, such; neuritis of the optic nerve, retinopathy due to diabetes, Macular degeneration as a result of ageing, glaucoma and inflammatory ocular disease [7,8].

Also Smoking cigarettes has a detrimental effect on the surface of the eye and alters the properties of some tears. It raises the likelihood of developing dry eye syndrome and aggravates pre-existing problems [9].

This study's objective was to evaluate the alterations to the ocular surface among smokers.

2. METHODOLOGY

This study included 100 subjects from both sexes, age ≥ 18 years, current smoker (a someone who has smoked more than 100 cigarettes in his lifetime and who presently smokes cigarette [10] and all types of smoking.

Exclusion criteria were associated ocular surface disease as blepharitis, allergy, previous ocular surgery as refractive surgery, cataract, past history of chemical injury, use of contact lenses and chronic use of eye drops and chronic ocular disease as glaucoma, systemic diseases as DM, autoimmune diseases as rheumatoid disease, SLE or sjogren syndrome.

Two groups of patients were formed: smokers (current smokers) (55 cases) and non-smokers (45 cases) who have never smoked and did not have smokers in their first-degree relatives to rule out the effect of passive smoking.

All patients were subjected to history taking, evaluation of visual acuity, investigation with a slit lamp (cornea, conjunctiva, and eyelid assessment), special tests (schirmer 2 test, tear break up time test, ocular surface staining and lower tear meniscus height measurement) and questionnaire.

3. QUESTIONNAIRE

It is a 12-item questionnaire used to assess Symptoms of dry eyes and its effects on visual function throughout the patient's last week of life. The total Ocular Surface Disease Index (OSDI)

score varied between 0 and 100and the scores were calculated and graded as following: 12 is considered normal, 13 to 22 is considered mild, 23 to 32 is considered moderate, and 33 is considered severe dry eye illness [11]. Among the inquiries were the following: type of smoking, smoking duration history, daily number of cigarettes smoked and years of smoking a pack were derived by multiplying the daily cigarette use by the years smoked and then dividing by twenty (the quantity of cigarettes included in a pack) [12].

Schirmer test was carried out by putting a Schirmer strip in the inferior fornix's lateral one-third after placing a single anaesthetic drop. After 5 minutes, the strip's wetted area was measured in millimetres (mm). A normal value is larger than 10 mm.

Tear break up time (TBUT) test was performed by instillation of fluorescein dye into the eye and blinking was requested of the patient several times for dye distribution then instructed to maintain a straight-ahead gaze without blinking and the structures of the eye were examined utilising the slit lamp's broad beam with the blue cobalt filter. The time interval between the final complete blink and the onset of the first break (black spot) in the fluorescent tear film is quantified. Values less than 10 seconds is considered abnormal. This method was done three times in each eye, with the average value in seconds being recorded.

Lower tear meniscus height (LTMH): We measured the LTMH utilising a slit lamp with a micrometre scale. It was accomplished by injecting fluorescein dye into the eye and instructing individuals to blink normally before ceasing to blink and looking straight ahead. LTMH was determined immediately following the last blink using a horizontal slit illuminated with cobalt blue light. LTMH was defined as the distance between the torn meniscus's upper and lower margins. The slit beam's lower margin was locked to the tear meniscus's lower margin, and the slit was enlarged to reach the tear meniscus's higher margin and the width of the slit was recorded.

Fluorescein staining: corneal punctate staining was assessed after instillation of fluorescein strip of impregnated paper (moistened with a saline drop) in the lower fornix. Then examine using cobalt blue filter with wide broad light beam of slit lamp. The National Eye Institute Workshop Scale was used to assess and grade staining (0 = no staining; 1 = few easily countable punctate spots; 2 = moderate staining or more easily countable punctate spots; 3 = punctate staining dense that has consolidated) in six quadrants for each eye (three bulbar conjunctiva on the medial and temporal sides).

Rose Bengal Staining: staining of conjunctiva was assessed by instillation of Rose Bengal impregnated paper strip (wetted with A drop of saline) into conjunctival sac. After two minutes, the bulbar conjunctiva was evaluated using a slit lamp with white light illumination.

Lissamine Green Staining: Instillation of Lissamine Green impregnated paper strip (wetted with A drop of saline) into conjunctival sac. After two minutes, the bulbar conjunctiva was assessed under white light illumination of slit lamp.

The National Eye Institute Workshop Scale was used to assess and grade conjunctival staining (0 = no staining; 1 = few readily countable punctate spots; 2 = moderate staining or more easily countable punctate spots; 3 = dense punctate staining that has consolidated) in six quadrants for each eye (three medial and three temporal bulbar conjunctiva).

Both dyes (RB &LG) have similar staining patterns on the ocular LG is more tolerable than RB on the surface, but unlike RB, it is not harmful to the corneal epithelium.

4. STATISTICAL METHOD

SPSS v25 was used for the statistical analysis (IBM Inc., Chicago, IL, USA). Using a paired Student's t-test, we compared the mean and SD of quantitative variables within the same group. Frequency and percentage were used to represent qualitative variables (percent). Sophistication and specificity of diagnostic tests as well as their accuracy and precision are all evaluated (NPV). Agreement: The paired Student's T test was used to compare the results of the measurements of TTE, and EC. Bias and its SD were calculated between TTE, and EC. TTE and EC measurements were plotted using modified Bland Altman plots. The significance level was set at a two-tailed P value of 0.05.

5. RESULTS

Age and occupation were significantly different between smokers and non-smokers with

Table 1. Relation between sociodemographic data and smoking status (n = 100)

Variable		Nonsmoker (n= 45)	Smokers (n= 55)				χ^2	P Value
			Mild (n=17)	Moderate (n=14)	Heavy (n=11)	Shisha (n=13)		
Age (years)		41.5 ± 10.37	37.1 ± 7.64	41.9 ± 8.02	45.6 ± 7.02	45.1 ± 5.66	9.581	0.048*
Gender	**Male**	19 (42.2%)	17 (100.0%)	14 (100.0%)	11 (100.0%)	13 (100.0%)	**MC** =	<0.001*
	Female	26 (57.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	42.943	
		P1 = <0.001*, P2 = <0.001*, P3 = 0.001*, P4 = <0.001*						
Occupation	**Not working**	19 (42.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	**MC** =	<0.001*
	Employee	7	2	3	1	3	54.002	
		15.6%	11.8%	21.4%	9.1%	23.1%		
	Manual worker	9	8	11	10	10		
		20.0%	47.0%	78.6%	90.9%	76.9%		
	Professional	10	7	0	0	0		
		22.2%	41.2%	0.0%	0.0%	0.0%		
		P1 = 0.007*, P2 = <0.001*, P3 = <0.001*, P4 = <0.001*						

*Data are presented as mean ± SD or frequency (%), MC (Monte Carlo Exact test), P1 (nonsmoker & mild smoker), P2 (nonsmoker & moderate smoker), P3 (nonsmoker & heavy smoker), P4 (nonsmoker & shisha smoker) χ^2 (Kruskal Wallis test), *: significant P value <0.05*

Table 2. Relation between OSDI and smoking status (n = 100)

Variable		Nonsmoker (n= 45)	Smokers (n= 55)				MC	P Value
			Mild (n=17)	Moderate (n=14)	Heavy (n=11)	Shisha (n=13)		
OSDI (dry eye)	**Mild**	14 (31.1%)	4 (23.5%)	0 (0.0%)	0 (0.0%)	2 (15.4%)	20.243	0.01 *
	Moderate	31 (68.9%)	13 (76.5%)	12 (85.7%)	11 (100.0%)	9 (69.2%)		
	Severe	0 (0.0%)	0 (0.0%)	2 (14.3%)	0 (0.0%)	2 (15.4%)		
		P1 = 0.557, P2 = 0.006, P3 = 0.033, P4 = 0.026						

*Data are presented as frequency (%), OSDI: ocular surface disease index, MC (Monte Carlo Exact test), P1 (nonsmoker & mild smoker), P2 (nonsmoker & moderate smoker), P3 (nonsmoker & heavy smoker), P4 (nonsmoker & shisha smoker), *: significant P value <0.05*

Table 3. Relation between Schirmer, TBUT, tests and smoking status (n = 100)

Variable		Nonsmoker (n= 45)	Smokers (n= 55)				χ^2	P Value
			Mild (n=17)	Moderate (n=14)	Heavy (n=11)	Shisha (n=13)		
Schirmer	Mean ± SD	11.5± 2.48	10.4 ±1.33	9.3 ± 0.99	9.4 ±1.03	9.5 ± 1.20	28.779	<0.001*
TBUT	Mean ± SD	9.9 ± 2.99	7.7 ± 1.94	6.4 ± 1.95	5.9 ±1.92	6.6 ± 1.98	35.590	<0.001*

*Data are presented as mean ± SD, TBUT: tear break up time, χ^2 (Kruskal Wallis test), P1 (nonsmoker & mild smoker), P2 (nonsmoker & moderate smoker), P3 (nonsmoker & heavy smoker), P4 (nonsmoker & shisha smoker), *: significant P value <0.05*

Table 4. Relation between T.M height test and smoking status (n = 100)

	Variable	Nonsmoker (n= 45)	Smokers (n= 55)				χ^2	P Value
			Mild (n=17)	Moderate (n=14)	Heavy (n=11)	Shisha (n=13)		
T.M height	Mean ± SD	0.2 ±0.06	0.2 ± 0.05	0.2 ± 0.08	0.1 ±0.05	0.1 ± 0.04	10.214	0.037*

*Data are presented as mean ± SD, χ^2 (Kruskal Wallis test), *: significant P value <0.05, T.M: tear meniscus height*

Table 5. Relation between Conjunctival staining, Corneal fluorescein staining and smoking status (n = 100)

Variable		Nonsmoker (n= 45)	Smokers (n= 55)				MC	P Value
			Mild (n=17)	Moderate (n=14)	Heavy (n=11)	Shisha (n=13)		
Conjunctival staining score	0	25 (55.6%)	9 (52.9%)	1 (7.1%)	0 (0.0%)	1 (7.7%)	56.856	<0.001*
	1	19 (42.2%)	8 (47.1%)	11 (78.7%)	5 (45.5%)	5 (38.5%)		
	2	1 (2.2%)	0 (0.0%)	1 (7.1%)	6 (54.5%)	5 (38.5%)		
	3	0 (0.0%)	0 (0.0%)	1 (7.1%)	0 (0.0%)	2 (15.3%)		
		P1 = 1.00, P2 = 0.003, P3 = <0.001, P4 = <0.001						
Corneal fluorescein staining score	0	33 (73.3%)	10 (58.8%)	3 (21.4%)	2 (18.2%)	4 (30.8%)	39.263	<0.001*
	1	10 (22.2%)	7 (41.2%)	5 (35.7%)	9 (81.8%)	7 (53.8%)		
	2	2 (4.5%)	0 (0.0%)	6 (42.9%)	0 (0.0%)	2 (15.4%)		
		P1 = 0.264, P2 = <0.001, P3 = 0.001, P4 = 0.018						

*Data are presented as frequency (%), MC (Monte Carlo Exact test), P1 (nonsmoker & mild smoker), P2 (nonsmoker & moderate smoker), P3 (nonsmoker & heavy smoker), P4 (nonsmoker & shisha smoker), *: significant P value <0.05*

(P =0.048, P<0.001 respectively). There was highly significant difference between non-smokers and smokers as a whole and between non-smokers and each group of smokers regarding sex with P value < 0.001, Table 1.

OSDI score was significantly different between smokers and non-smokers with P value 0.01, between non-smokers and moderate smokers with P value = 0.006, between non-smokers and heavy smokers with P value = 0.033 and between non-smokers and shisha smokers with P value = 0.026, Table 2.

Schirmer 2 test values were significantly decreased in smokers more than non-smokers with P value <0.001. TBUT was significantly lower in smokers more than non-smokers with P value <0.001. Table 3.

T.M height was significantly lower in smokers more than non-smokers (P = 0.037). Table 4.

Conjunctival staining was significantly higher in smokers than non-smokers with P value <0.001 and there was significant increase in punctate corneal staining in smokers than in non-smokers with P value <0.001, Table 5.

6. DISCUSSION

Cigarette consumption is a significant risk factor for a variety of illnesses, considering cardiovascular, pulmonary, and malignant disorders. Additionally, it is a risk factor for a variety of eye illnesses, such as cataract, macular degeneration, and glaucoma. Additionally, it is believed that cigarettes' ischemia, toxic, and oxidative effects contribute significantly to ocular tissue damage and the development of Disease of the dry eye symptoms [13].

This work showed that the severity of dry eye symptoms increased significantly in smokers more than non-smokers according to the OSDI scores with P value 0.01 and scores increased with increasing the severity of smoking as there was significant difference between non-smokers and moderate smokers with P value = 0.006, between non-smokers and heavy smokers with P value = 0.033 and between non-smokers and shisha smokers with P value = 0.026 but there was insignificant difference between non-smokers and mild smokers.

This finding was similar to the results of Bhutia P [14] who observed that the mean symptomatic assessment score (OSDI) was statistically significant higher in smokers than in non-smokers(P < 0.001).

On the contrary, Bakkar M [15] reported that the difference in the average OSDI scores in the study groups was not statistically significant (P > 0.05).

In this study, Schirmer II test results were lower in smokers compared to non-smokers with P value <0.001. And the results decreased with increasing the severity of smoking as there was significant difference comparing non-smokers& moderate smokers with P value <0.001, non-smoker & heavy smokers with P value = 0.006, and non-smokers & shisha smokers P value = 0.019) but there was statistically insignificant difference between non-smokers & mild smokers.

Our result agreed with Agrawal N [16] who reported that the average score obtained on Schirmer's test was 12.58 ± 2.79 mm in non-smokers as compared to 10.40 ± 2.64 mm in smokers with statistical significant difference (P=0.001). In analyses of subgroups, the mean Schirmer’s test was 8.77 mm among heavy smokers while in mild smokers it was 11.5 mm (P=0.002).

On the other hand, Thomas J. [17] reported that the mean Schirmer's 2 test value differ insignificantly comparing smokers and non-smokers with P-value =0.22. This demonstrates that there is no connection between cigarette use and aqueous production.

In this study, smokers had a statistically significant drop in TBUT levels compared to non-smokers with P value <0.001 and this decrease was more with increasing the severity of smoking. There was significant difference comparing non-smokers & moderate smokers with p value <0.001, non-smokers & heavy smokers with p value <0.001 and non-smokers & shisha smokers with p value = 0.002. But there was no statistically significant difference between non-smokers & mild smokers.

Also our results like Bakkar M [15] study results who found that the mean values obtained from TBUT test were significantly lower (P < 0.05) in the waterpipe smokers group (5.82 ± 3.77 s) compared to the non-smokers group (8.32 ± 3.46 s).

In addition, our results agreed with Mohidin N [18] who reported that the smokers group had significantly lower tear film stability than the non-smokers group (P< 0.0001).

Regarding the tear meniscus height (TMH), we found that there was a significant decrease in TMH values in smokers more than non-smokers with P value < 0.05 (P = 0.037) but there was insignificant difference by increasing the severity of smoking. Mean TM height in non-smokers was 0.2 mm ± 0.06 SD, in mild smokers was 0.2 mm ± 0.05 SD, in moderate smokers was 0.2 mm ± 0.08 SD in heavy smokers was 0.1 mm ± 0.05 SD and in shisha smokers was 0.1 mm ± 0.04 SD.

This was similar to the results of Bhutia P et al. [14] who reported that the mean TMH levels were significantly lower among smokers (0.23 ± 0.06 mm) than non-smokers (0.36 ± 0.0.12 mm (P < 0.0001)).

The current study findings showed that, there was significant increase in conjunctival staining score in smokers more than non-smokers (P value <0.001) and there was significant difference between non-smokers and each group of smokers (between non-smokers and moderate smokers with P value = 0.003, between non-smokers and heavy smokers with P value <0.001 and between non-smokers and shisha smokers with P value <0.001 but there was no statistically significant difference between non-smokers and mild smokers).

This was different from Khalil HM [19] results that showed that the staining scores for rose Bengal were not significantly different between the two groups (P=0.467).

This research reported that there was significant increase in punctate corneal staining in smokers than in non-smokers with P value <0.001, also there was significant difference between non-smokers and moderate smokers with P value <0.001, between non-smokers and heavy smokers with P value = 0.001 and between non-smokers and shisha smokers with P value = 0.018 but there was no statistically significant difference between non-smokers and mild smokers.

These results were consistent.to the results reported by Bakkar M [15] who reported that the mean values of corneal staining were significantly higher in the waterpipe smoking group (0.73 ± 0.94) compared to the non-smokers group (0.10 ± 0.30) (P < 0.05).

This also similar to the results of Mohidin N [18] who reported that In smokers, corneal staining was statistically significantly greater in the nasal and temporal regions of the cornea (P < 0.05).

Also Thomas J [17] found that superficial punctate corneal staining was significantly higher in smoker group compared to non-smoker group (p<0.0001). And this was similar to the results.

7. CONCLUSIONS

Smoking influences the secretion and stability of the tear film.; The staining of the cornea and conjunctiva was found to be more widespread in smokers. Additionally, smoking irritates the eyes; smokers are more likely to develop dry eyes, and the seriousness of dry eye is greater in smokers than in non-smokers. Additionally, the severity of Symptoms of dry eyes increased with increasing the amount of smoking.

CONSENT AND ETHICAL APPROVAL

All patients provided written informed consent. The research was done after approval from the Ethical Committee Tanta University Hospitals.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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