Original Article

Effect of Smoking on Retinal Nerve Fiber Layer Alterations and Dry Eye Disease in Chronic Smokers

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ABSTRACT

Smoking has an impact on the eyes as well because the toxins it contains cause blood flow to be reduced and obstructions to develop in the ocular capillaries, depriving the eye of nutrients that are crucial to its health. **Objectives:** To evaluate impact of smoking on thickness of the Retinal Nerve Fiber Layer (RNFL) and symptoms of dry eye in chronic smokers. **Methods:** This study was conducted at Madinah Teaching Hospital, Faisalabad in duration of Sep-Dec, 2023. 30 smokers (60 eyes) who had smoked ≥ 25 cigarettes a day for 10 years were enrolled. For comparison, an equal number of healthy non-smoker were participated as controls. Using a self-structured proforma, data were collected using a non-probability purposive sampling technique. In addition to a thorough history evaluation, a comprehensive slit-lamp examination was performed. schirmer test, Tear Film Breakup Time (TBUT), meibomian gland dysfunction grading and Optical Coherence Tomography (OCT) for RNFL examination were performed. SPSS software was used for analyzing the data. **Results:** Average age was 49 ± 1.78 years. Each participant was male. Mean schirmer value for smokers was 8 ± 1.71, while the average for non-smokers was 17 ± 1.36 (p=0.02). Similarly, smokers had a tear breakup time of 6 ± 1.89, while non-smokers had a tear breakup time of 15 ± 1.27 (p=0.00). According to the results, smokers' tear film stability is considerably less than that of non-smokers. RNFL thinning was detected in all quadrants in smokers compared to non-smokers (p=0.00). **Conclusions:** Smoking over an extended period of time is associated with a higher risk of developing dry eye disease and thinning of RNFL.

INTRODUCTION

Tobacco smoking is the most preventable cause of morbidity in the world, taking the lives of seven million individuals each year [1]. Smoking has a negative effect on eye health as well. The carcinogens in tobacco reduce blood flow and cause blockages to form in the capillaries of the eyes, which results in a shortage of essential nutrients required to maintain the eyes healthy [2]. Smokers have larger concentrations of activated platelets, leukocytes and erythrocytes than non-smokers possess. This results in increased blood viscosity and a higher risk of thrombus formation in blood vessels [3, 4]. When these factors combine together, it elevates the risk of ocular ischemia,

interference with cellular functions, and eventually contribute to a variety of ocular conditions [5]. The complex condition referred to as Dry Eye Disease (DED) is represented by anomalies in the tear film along with symptoms such as inflammation, redness, sensitivity to light and blurred vision [6]. Numerous factors, including medication, age, gender, lifestyle choices and systemic diseases, can influence the development of Dry Eye Disease (DED) [7, 8]. Untreated cases of severe dry eye may end to blindness, infectious keratitis, and corneal scarring [9]. Since smoking can lead to peroxidation of the pre-corneal tear film, the outermost layer of the tear film, it has

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been determined that smoking constitutes a major risk [10, 11]. Through the metabolic and vascular effects of systemically absorbed products, cigarette smoking causes damage that has been shown to be a risk factor for atherosclerotic problems in the cerebral, aortic and coronary circulations [12, 13]. Free radicals are created by oxidizing substances found in tobacco smoke, which have the ability to cause cell damage and death. Smoking has dose-dependent hazards for the eyes, with an increase in smoking index being correlated with an increase in morbidity [14]. Smokers who already have visual disorders such as diabetic retinopathy or glaucoma may experience faster optic nerve degeneration since these ailments already impair the Retinal Nerve Fiber Layer (RNFL). Thickness of retinal nerve fiber layer varies in smokers [15]. This study was carried out in order to fill a specific research gap, even though a substantial amount of literature already suggests that smokers are more likely to develop dry eye disease and that there is not much knowledge on the effects on the Retinal Nerve Fiber Layer (RNFL). The current study examines the thickness of the Retinal Nerve Fiber Layer (RNFL) and symptoms of dry eye in long term smokers.

METHODS

A pilot study was conducted at Madinah Teaching Hospital, Faisalabad in duration of September 2023 to December 2023. Participants in the study were thirty smokers (sixty eyes) who regularly smoked at least twenty-five cigarettes per day for 10 years. A letter of ethical approval for this research (TUF/IRB/248) was issued by the University of Faisalabad, Ethical Institutional Review Board on August 11, 2023. Based on a review of the literature and an empirical approach, the sample size has been found as 30 participants. A consequence of the study's time constraints was the small sample size. Participants in the study included 15 smokers (30 eyes) and 15 healthy people (30 eyes), matched for age and sex. For comparison, an equal number of healthy non-smokers with no other systemic or ocular disease were participated as controls. As a recruited thirty smokers (60 eyes) who smoked at least twenty-five cigarettes a day. Individuals who smoked 25 cigarettes or more a day for 10 years were considered habitual chronic smokers. Nonprobability purposive sampling technique was used to collect the data. Participants in the study ranged in age from 35 to 45 years, having clear media, an intraocular pressure below 20 mmHg, a spherical refraction between +2.0 and -2.0 diopters, and Best Corrected Visual Acuity (BCVA) of 20/20 or better. Those with a history of ocular surface conditions that impair tear production or secretion such as sjogren's syndrome, Stevens-johnson's syndrome, allergic or infectious conjunctivitis, blepharitis, long-term contact lens wear, notable lid abnormalities or dry eye disease were

excluded. Individuals who had undergone recent eye surgery within the previous three months, a history of ocular trauma or chemical burns, frequent use of visual display systems, glaucoma, retinal disorders, optic nerve pathology or other underlying problems were also eliminated. Following the guidelines set forth in the Declaration of Helsinki, prior approval was sought from the institutional ethical committee and consent was given by each participant. Demographic data were obtained, such as the patients' ages, gender. The inclusion criteria for this study were limited to people who had smoked 25 cigarettes a day for ten years. The number of cigarettes smoked regularly was one of the beneficial indicators of smoking duration. A comprehensive slit-lamp examination was performed to examine the anterior and posterior segments, in addition to a detailed investigation of the patient's history. Every patient was subjected to the Schirmer's I test, Tear Film Breakup Time (TBUT), and Optical Coherence Tomography (OCT) for Retinal Nerve Fiber Layer (RNFL) assessment. Tear breakup time and the anterior segment were examined under a slit-lamp biomicroscope. Prior the exam, the severity of the dry eye was assessed using the OSDI questionnaire. The patients' symptomatology was evaluated using the Ocular Disease Surface Index (OSDI) questionnaire, which has a scale from 0 to 100. Higher scores are indicative of greater severity of symptoms. This assessment was then split up into four groups for categorization considerations. People who scored in the range of 0 to 12 were categorized as having normal indications. Individuals with scores ranging from 13 to 22 were classified as having mild dry eyes, while those with scores between 23 and 32 were classified as having moderate dry eyes. People who scored 33 or higher were classified as having extremely dry eyes. This classification made it possible to get a thorough grasp of the different levels of symptom severity among the individuals. An extensive evaluation of the ocular surface was performed. The Tear Film Breakup Time (TBUT) and Schirmer's I test were performed. The thickness of the RNFL was assessed by optical coherence tomography. Each of the RNFL's four quadrants the nasal, superior, inferior, and temporal was evaluated separately. Statistical Package for Social Sciences (SPSS version 22.0) was used for analyzing the data. The age distribution and OSDI grading in both groups were evaluated using descriptive statistics. Variables including the Schirmer test, TBUT, and retinal nerve fiber layer thickness were compared between smokers and non-smokers in all quadrants using an independent t-test.

RESULTS

The participants' average age was 49 ± 1.78 years. Each participant was male. A descriptive statistical analysis included frequency distributions of the Ocular Surface Disease Index (OSDI) grading for both groups: smokers and non-smokers. Higher scores on the Ocular Disease Surface

Index (OSDI) questionnaire reflect more severe symptoms. The scale rages from 0 to 100. Nineteen individuals in the nonsmoker group of this study were defined as having a normal state without dry eyes, while 6 individuals were diagnosed as having mild dry eye using the OSDI scale. Three of the smoker group's members were found to have mild dry eye symptoms, while eight were found to have moderate symptoms. In addition, four subjects showed signs of severe dry eye as in shown in table 1.

Table 1: Ocular Disease Surface Index (OSDI)

OSDI	Grading	Smokers N (%)	Non-Smokers N (%)
0 to 12	Normal	-	9 (60%)
13 to 22	Mild Dry Eyes	3 (20%)	6 (40%)
23 to 32	Moderate Dry Eyes	8 (53.33%)	-
33 and above	Severe Dry Eyes	4 (26.66%)	-

An independent t-test was conducted to statistically analyze dry eye parameters - Schirmer test I (mm) and TBUT (sec) of both groups: smokers and non-smokers. The mean Schirmer value for smokers was 8 ± 1.71, while the average for non-smokers was 17 ± 1.36 (p=0.02). Similarly, smokers had a tear breakdown time of 6 ± 1.89, while non-smokers had a tear breakup time of 15 ± 1.27 (p=0.00). According to these results, smokers' tear film stability is considerably less than that of non-smokers as in shown in table 2.

Table 2: Tear Film Assessment

Variables	Smokers (Mean ± SD)	Non-Smokers (Mean ± SD)	p-Value
TBUT (sec)	6 ± 1.8	15 ± 1.27	0.00
Schirmer test I (mm)	98 ± 1.71	17 ± 1.36	0.02

An independent t-test was conducted to figure out the thickness of the nerve fiber layer in all quadrants for both groups: smokers and non-smokers. RNFL thinning was detected in all quadrants specifically superior and inferior quadrants in smokers compared to non-smokers (p=0.00). This study reveals that subjects with a positive history of smoking had a lower retinal nerve fiber layer (RNFL) as compare to nonsmokers as shown in table 3.

Table 3: Thickness of Nerve Fiber Layer in Smokers and Non-Smokers (n=15)

Retinal Nerve Fiber Layer Thickness (μm)	Smokers (Mean ± SD)	Non-Smokers (Mean ± SD)	p-Value
Superior	109 ± 8.31	116 ± 9.03	0.00
Inferior	111 ± 11.4	121 ± 13.31	0.00
Temporal	65 ± 9.34	73 ± 11	0.04
Nasal	72 ± 13.71	81 ± 10.5	0.02

DISCUSSION

Smoking produces a variety of deleterious changes to the human body, including variations to the eyes, which increase the risk of disease and early mortality [16]. Smoking alters the lipid layer of the tear film, decreases basal secretion, decreases corneal and conjunctival sensitivity, lowers tear lysozyme concentration and can accelerate the onset of squamous metaplasia in the conjunctiva, among other changes to the ocular surface [17, 18]. A popular approach for measuring basal and reflex tear secretion is the Schirmer test. Smoking is known to cause lipid peroxidation, which damages the pre-corneal tear film. The Schirmer test results for smokers and nonsmokers were measured and compared in this study. The findings showed that smokers' levels were much lower than those of nonsmokers [19, 20]. Schirmer's test readings have also been found to be lower in smokers in previous studies, with one study finding that the reduction persisted as pack-years increased [21]. Smoking cigarettes causes histological alterations in the conjunctiva as well as alters the tear film's protein composition. Conjunctival and corneal sensitivity are reduced as a consequence of these modifications to the subbasal corneal nerve plexus. Schirmer measurements and basal tear secretion consequently drop. The inflammatory mediators from smoking, which can cause long-term inflammation of the ocular surface, are another potential reason. Further lowering reflex secretion could result from neurosecretory blockage brought on by this medical condition [22]. In a comparable way, research discovered that smokers' TBUT values were much lower than those of nonsmokers. Similar results were observed in the studies by Satici A *et al.*, and Khalil HE *et al.*, which showed that smokers' TBUT was considerably lower than that of nonsmokers' [21, 23]. The main explanation appears to be a biochemical assault by the free radicals in cigarette smoke on the lipid layer of the pre-corneal tear film. Damage is also exacerbated by cellular and inflammatory processes on the surface of the eyes. There is a clear correlation between smoking and reduced tear film quantity and quality. In this study, the thickness of the RNFL was evaluated in smokers and nonsmokers. Additionally, RNFL in each quadrant was assessed and the results indicated a significant decline in each quadrant favoring the adverse effects of smoking on the retina. This study is in line with a study by Dervişoğulları MS *et al.*, who discovered the similar effects of smoking on RNFL in their investigation and recommended taking this into account when interpreting the results in those who smoke [24]. Another study carried out in Turkey corroborated Demirci S *et al.*, suggestion that smoking causes a decrease in RNFL [25]. In their study, Nita M *et al.*, also mentioned that smoking may result in a number of ocular pathologies [26]. Individuals who have smoked heavily over an extended period of time in past times show a decrease in the thickness of the Retinal Nerve Fiber Layer (RNFL). Rather than the duration of smoking, the quantity of smoking seems to be more directly linked to this reduction. This reduction could be due to nicotine's direct neurotoxic effect on the optic nerve as well as its vasoconstrictive effects, which reduce blood flow [27]. This study concluded that subjects with a positive history of smoking had a lower Retinal Nerve Fiber Layer (RNFL). This study's

strength, focuses exclusively on the consequences of heavy smoking over an extended period of time on the health of the eyes, particularly the integrity of the Retinal Nerve Fiber Layer (RNFL) and the incidence of dry eye. This comprehensive approach highlights how smoking significantly affects the quantity and quality of tear films, highlighting the need for vision specialists to inform smokers about these potential risks. In future, including RNFL thickness measures into early detection techniques may improve the capacity to effectively prevent and manage smoking-related ocular disorders. This study promotes proactive health education among smokers to protect their overall health and vision..

CONCLUSIONS

In conclusion, the study's results show that smoking has a negative impact on the overall health of the ocular surface, with the consequences becoming more noticeable with increased smoking frequency. Smoking specifically aggravates dry eye and thinning of the retinal nerve fiber layer.

Authors Contribution

Conflicts of Interest

The authors declare no conflict of interest.

Source of Funding

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