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Original Research Article

Outcomes of a survey of dry eye disease amongst cigarette smokers in a peripheral medical college

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ABSTRACT

Aim: To find out an association, if any, between smoking and dry eye diseases and whether it has any relation to the number of cigarettes smoked.
Materials and Methods: Patients attending the hospital outpatient department were enquired about smoking and then given the option to enrol in the study following a written and informed consent. Depending on the number of cigarettes they smoked, patients were divided in three groups, namely low, moderate and high smokers based on the heaviness of Smoking Index. They were labelled as Group A, B and C respectively. Symptomatic assessment of each group was done by the Ocular Surface Disease Index (OSDI) questionnaire, and a score greater than 12 was considered meaningful. Clinical evaluation was done by performing TBUT and Schirmer's test. Respective cut off values were 10 seconds and 10 mm. Deviations from established normal values were observed and analyzed.
Results: A total of 205 patients participated in this study of which 90.7% (n= 186) were males and 9.3% (n= 19) were females. 30.7% (n= 63) patients were low smokers (Group A), 42.9% (n= 88) were moderate smokers (Group B) and 26.3% (n= 54) were high smokers (Group C). The mean TBUT and OSDI scores showed progressive deterioration from Group A to C, whereas the mean Schirmer's values across all groups remained relatively unaffected.
Conclusion: Cigarette smoking had a deleterious effect on the health of the ocular surface, but the aqueous tear secretion remained unaffected.

1. Introduction

Dry eye syndrome reffers to a situation where the normal health of the ocular surface is adversely affected due to disturbance of one or more components of the pre corneal tear film. The proximal or mucin layer is secreted mostly by the goblet cells and the accessory mucin secretors namely the crypts of Henle and the glands of Manz. Sparsenes of this layer, as happens for example in Vitamin A deficiency, can cause ocular dryness even in the presence of adequate aqueous tear secretion. Aqueous tears – secreted from the lachrymal and the accessory lachrymal glands, is responsible for debridement and immunologic ocular surface defence. Multi organ disease like kerato conjunctivitis sicca can cause considerable reduction in aqueous tear production thereby leading to serious unwanted effects n the ocular surface. The most distal of the three layers - - the lipid layer is secreted mainly by the mebomian glands and is entrusted with providing vertical stability to the pre corneal tear film and also preventing its evaporative loss. In mebomian gland dysfunction (MGD), the functionality of the lipid layer is affected, leading to quicker evaporation of the aqueous layer thereby causing dryness of the ocular surface.

Cigarette smoking has been shown to exacerbate the symptoms of dry eyes disease. The main intention of this study was to find out the nature and extent of insult that cigarette smoking had on the pre corneal tear film

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and whether it was in any way related to the quantity of cigarettes consumed.

2. Aims and Objectives

1. To find out whether smoking affected the health of the ocular surface in any way
2. To assess whether there was any association between the severities of dry with the number of cigarettes smoked.

3. Materials and Methods

The study was carried out on an outpatient basis at a peripheral medical college in West Bengal. It extended for a period of approximately three months from January to end March 2019. Informed consent was taken from all participants and confidentiality was ensured.

3.1. Inclusion criteria

Patients attending OPD of Ophthalmology department in a peripheral tertiary hospital in West Bengal were enrolled for this study. Smokers in this study included cigarette smokers only. Other types of smoking devices like pipes, cheroots etc are not commonly prevalent in this part of the country and therefore excluded.

3.2. Study methodology

The entire examination process essentially had three components:

1. Assessment of the severity of cigarette smoking, which was done by verbal questioning based on the Heavy Smoking Index Scale.[1] Socio demographic data was also collected simultaneously during the interview process.
2. Symptomatic evaluation of dry eyes by questions based on OSDI (Ocular Surface Disease Index)[2] questionnaire.
3. Clinical evaluation of dry eyes by TBUT measurement and Schirmer's test

3.2.1. Assessment of the severity of cigarette smoking

Questions based on the Heaviness of Smoking Index Scale[1] were chosen to classify smokers.

1. On the days that you smoke, how soon after you wake up do you have your first cigarette?
   a) Within 5 minutes (3 points)
   b) 6- 30 minutes (2 points)
   c) 31-60 minutes (1 point)
   d) After 60 minutes (0 points)
2. How many cigarettes do you typically smoke per day?

   a) 10 or fewer (0 points)
   b) 11-20 (1 point)
   c) 21-30 (2 points)
   d) 31 or more (3 points

Scoring:
0-2: low addiction – Group A
3-4: moderate addiction- Group B
5-6: high addiction - Group C

3.2.2. Subjective / symptomatic assessment

A subjective evaluation of the patients' symptomatology was done on the basis of Ocular Disease Surface Index (OSDI)[2] questionnaire. It was assessed on a scale of 0 to 100, higher scores meaning greater severity. It was further sub divided into four categories as mentioned.

1. Normal 0 to 12
2. Mild dry eyes 13 to 22
3. Moderate dry eyes 23 to 32
4. Severe dry eyes 33 and above

3.2.3. Objective/clinical assessment

First, a comprehensive eye evaluation included recording the best corrected visual acuity and the intraocular pressure by a non contact method. A thorough examination of the ocular surface was then completed with a slit lamp bio microscope. Dilated fundus examination was intentionally withheld to avoid the effect of any topically applied medication on the pre corneal tear film. Specific tests were then performed to assess the ocular surface in the order as mentioned.

1. Tear film breakup time.
2. Schirmer test.

The tests were carried out in sequence, the tear film break up time (TBUT) first and the Schirmer's test without anaesthesia next. TBUT test was done separately in both eyes and their mean was taken. This sequence of testing - TBUT first and Schirmer's next – was adopted to minimize any error due to reflex tearing.

(TBUT) test was done by touching a strip of fluorescin filter paper in the lower lateral fornix and asking the patient to blink. The interval between the last complete blink and the appearance of the first corneal dry spot in the stained tear film was measured. As already mentioned, the mean value of the measurements of the two eyes was taken. A TBUT value of less than 10 seconds was considered abnormal.

Schirmer-1 test was done without topical anaesthesia bilaterally, by the standardized strips of filter paper placed in the lateral canthus away from the cornea and left in place for 5 min with the eyes closed. Readings were recorded in millimetres of wet strip. Again a mean of the two eyes was accepted. A value of less than 10 mm was considered abnormal.

3.3. Exclusion criteria

As the main intention of this study was to find a co-relation between smoking and dryness of eyes, patients with other co morbidities, especially those that might have affected the health of the ocular surface were excluded from this study. That included:

1. Patients using contact lenses.
2. Patients with history or presence of pre existing ocular surface disorder.
3. Patients with history of any ocular surgery or trauma
4. Patients with lid anomalies or inappropriate lid dynamics from any cause
5. Patients with any ocular medications, especially those containing preservatives like BAK.
6. Patients on systemic medications like diuretics, antihistamine, anti cholinergics, psychotropic and oral contraceptives which might affect the pre corneal tear film.
7. Any history with co existent systemic diseases like lymphoma, amyloidosis, sarcoidosis, autoimmune collagen vascular diseases etc.
8. History of radiation of head and neck.

3.4. Plan for data analysis

Data were presented in simple numbers and percentages.

4. Results

4.1. Demographics

A total of 205 patients were surveyed in this study. The age and sex distribution is shown in Table 1.

Table 1:

Age in Yrs	Number	Percentage
18 -20	12	6.3%
21 – 40	90	44.4%
41-60	98	46.5%
61 -70	5	2.8%

Table 2:

Sex	Number	Percentage
Males	186	90.7%%
Females	19	9.3%

4.2. Other demographic characteristics

As is evident from Table 4, 42.2% of the patients were in the low income group. The report of Tendulkar committee[3] which stated that people earning below Rs 47 per day should be considered below poverty line was accepted as the yardstick in this study. Also 74.2% patients were seen to be literate, which might lead one to presume that they might have had some idea of demerits of tobacco smoking. 67.5% patients were wage earners, which favourably corresponded to the statistical expression of the socio economic status. However we would like to explicate that findings of Table 4 were collateral observations that have been shared, and had no bearing on the final outcomes of this study.

Table 3:

Economic status	Low income	Middle income
	87 (42.2%)	118 (57.8%)
Education	Illiterate	Literate
	53 (25.8%)	152 (74.2%)
Occupation	Wage earner	Non wage earner
	138 (67.3%)	67 (32.7%)

4.3. Distribution on the basis of smoking index

Table 4: Shows the number of smokers classified according to Heaviness of Smoking Index Scale.

Group	HSI Scale	Number	Percentage
A	Low	63	30.7%
B	Moderate	88	42.9%
C	High	54	26.3%
	Total	205	100

4.4. Clinical parameters in the different smoking groups

Table 5 portrayed how the various ocular surface indices, namely OSDI score, TBUT value and Schirmer's test values were affected in smokers. As was noted from the table, symptomatic scores related to dry eyes as depicted by the OSDI score were adversely affected by smoking. On the clinical front, it was noted that the mean TBUT time was appreciably shortened as the number of cigarettes smoked went up. However increase in the quantity of smoking had no perceptible effect on the mean Schirmer's test values across all the groups.

4.5. Absolute number of smokers with parameters suggestive of dry eyes

In Table 6, it was seen that as the number of cigarette consumption increased, more number of people we re adversely affected in terms of ocular surface health. For example, 42.8% and 36.5% of patients in Group A had abnormal OSDI and TBUT values respectively. The same figures went up to 79.6% and 77.7% in Group C respectively. However, values of Schirmer's test remained unaffected across all cohorts.

Table 5:

Group	HSI scale	Number	Mean OSDI score	Mean TBUT value In seconds	Mean Schirmer's value
A	Low	63	11	11 s	17.6 mm
B	Medium	88	24	7.9 s	16.8 mm
C	High	54	31	4.7s	15.9 mm

Table 6:

Group	HSI scale	Number	No of patients with OSDI > 12	No of patients with TBUT <10 SECONDS	No of patients with SCHIRMER 'S < 10 MM
A	Low	63	27(42.8%)	23(36.5%)	5 (7.9%)
B	Medium	88	57(64.7%)	61(69.3%)	7 (7.9%)
C	High	54	43(79.6%)	42(77.7%)	4 (9.2%)

5. Discussion

The National Eye Institute/Industry Workshop on Clinical Trials in Dry Eyes[4] defined dry eye as "a disorder of the tear film due to tear deficiency or excessive tear evaporation, which causes damage to the inter-palpebral ocular surface and is associated with symptoms of ocular discomfort". From a clinical viewpoint, dry eye is one of the most frequent disorders encountered in ophthalmology practice. Also true is the fact that this condition is often overlooked or under diagnosed.[5] As there is no definitive test for diagnosing dry eyes, different studies have used diverse diagnostic criteria. Some studies have used only symptoms, whereas others have used both symptoms and signs to arrive at a diagnosis.[4] However, as symptomatology forms an important diagnostic component in dry eye disease, it was decided to incorporate this in this study.[4,5]

As this study partly focused on the relation of dry eye diseases to the number of cigarettes smoked, the entire study population (n=205) was divided into three groups, namely A. B and C based on the heaviness of Smoking Index Scale.[1] The symptomatic and clinical parameters were then separately evaluated in each smoking group. We purposefully chose the Ocular Surface Disease Index (OSDI) scale as an instrument to quantify the symptomatology. This was because of the simplicity of the questionnaire and the uncomplicated numeric interpretation.[2] The TBUT and the Schirmer's test were used for clinical evaluation as these tests form the backbone of ocular surface assessment. While the Schirmer's test focuses on the status of the aqueous tear secretion, the TBUT quantifies the overall stability of the pre corneal tear film, which is again dependent on the integrity of the outermost lipid layer of the aforesaid structure.[6]

The mechanisms by which cigarette smoke affects, rather damages, the pre corneal tear film are manifold. Cigarette smoke has a complex chemical composition, and contains free radical species, aldehydes, peroxides, epoxides, peroxyl radicals and other pro oxidants.[7] It has been estimated that the ocular surface is exposed to more than fourteen such radicals in the gas phase per puff and even more during the tar phase. Also has been seen that radicals during the tar phase persisted for a longer time than the gas phase.[7,8] Altinors et al[9] demonstrated that these radicals damaged the lipid layer of the pre corneal tear film by lipid per oxidation process, which in turn enhanced the rate of tear film breakdown. This biochemical assault was by far the most important mechanism of tear film damage in cigarette smokers.[9,10] Study done by Matsumoto et al[11] using lipid layer interferometry reported significant increase in tear evaporation rate and slowing down of lipid spread time in chronic smokers, which further substantiated the above findings.

Other mechanisms included ocular surface epithelial damage caused by persistent inflammation and retarded epithelial differentiation caused by direct contact with the free radicals and pro oxidants present in cigarette smoke.[12] Satici et al[13] reported higher amount of squamous metaplasia was seen on the conjunctival surface in smokers as compared to non smokers. The toxins also caused ocular surface irritation which explained the frequent presence of conjunctival reaction in smokers.[14,15] Other reported findings included reduced conjunctival sensitivity, reduced goblet cell density and alteration in the tear proteins.[15] Brush cytology examination of the conjunctiva in smokers had revealed a higher concentration of neutrophil infiltration, which again substantiated the presence of ocular surface inflammation.[11] It was postulated that ocular surface inflammation caused an up regulation in the level and activity of proteolytic enzymes like plasmin and matrix metalloprotease which further contributed to surface epithelial cell damage.[11,13,16–18]

In our study, we found an increase in mean OSDI scores form Group A through Group C, implying worsening of dry eye symptom as the number of cigarette intake increased. We also found that as 79.6% of Group C patients had an OSDI score greater than 12, implying majority of smokers suffered from dry symptoms. This was consistent with the

findings of Matsumoto et al,[13] who found that 80% of their study subjects suffered from one form of dry eye symptom or the other.

We also found a shorter mean TBUT value in smokers, progressively worsening with the increase in number of cigarettes inhaled. The mean TBUT value in Group B was 7.9 seconds and consistent with the findings of Thomas et al[12] (7.26 seconds). The mean TBUT value in Group C was 4.7 seconds and consistent with the findings of Matsumoto et al[11] (3.2 seconds). However, none of these studies categorised smokers in terms of quantity of smoking. Also, our search of the literature did not reveal any report where TBUT had been quantified separately in relation to a smoking scale or index.

Across all the groups in our study, we found that the Schirmer's test value remained largely unaffected. Similar findings were also reported in separate studies by Altinors, Matsumoto and Thomas.[9,11,12]This was perhaps due to the fact that cigarette smoke – as already discussed – affected mostly the lipid layer of the tear film and the cellular structure of the ocular surface but left the aqueo us secretion from the lacrimal apparatus unharmed.[9,11,12,14]

The uniqueness of this study lied in the fact that we were able to segregate and categorize smokers into various groups based on the amount or number of cigarettes they smoked, and titrate symptomatic and clinical parameters separately in each of these group. One aspect the authors felt was left unaddressed – the duration of smoking, that is the number of years the person had been addicted to cigarettes. Whether that has any additional effect on the health of the ocular surface shall require a separate study to be investigated.

6. Conclusion

In conclusion, the authors affirm that smoking has a deleterious effect on the overall health of the ocular surface, the aforesaid effect being compounded by an increase in the quantity of smoking. The main mechanism appeared to be a biochemical assault on the lipid layer of the pre corneal tear film by the free radicals present in cigarette smoke, but inflammatory and cellular processes involving the ocular surface also had a role to play. The aqueous layer of the tear film however is left unharmed in this ordeal.

7. Source of Funding

None.

8. Conflict of Interest

None.

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