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Impact of Dry Eye on Visual Acuity and Contrast Sensitivity: Dry Eye Assessment and Management Study

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Abstract

The main objective of this study is to identify the signs or symptoms of dry eye disorder with particular visual function, which may build more possibilities to approach better treatment. Moreover, the purpose of this study is to determine the association of dry eye signs with visual acuity and contrast sensitivity. Baseline data was collected through the screening and eligibility visits therefore, standard procedure was adopted to obtain the score on the Ocular Surface Disease Index (OSDI), and performed contrast sensitivity, treat break uptime, tear film debris, corneal fluorescein staining, meibomian gland evaluation, conjunctival lissamine green staining, and Schirmer's test scores. General linear models were used to evaluate the association of dry eye signs among the visual acuity, contrast sensitivity with OSDI score, and for multiple comparisons, the Hochberg procedure was used. The results of 243 participants (486 eyes) shows poor visual acuity was not substantially associated with a worse mean score of OSDI including subscale score such as the mean of worse visual acuity 20/32 was 26.3 and 21.5 for better visual acuity 20/16 along with the linear trend p-value 0.92. The substantial association of severe Meibomian gland plugging was found with worse mean log contrast sensitivity analysis having a score of 1.38 for severe and 1.45 for non-plugged with linear trend p-value 0.03. As tear break up time was substantially related to better mean log contrast sensitivity, at TBUT >5, contrast sensitivity 1.47 was measured and 1.41 for tear breakup time >2 seconds. In multiple comparisons, both Meibomian gland and tear break up time was studied together that had adjusted the age, refractive error and cataract status, showed a substantial relationship with contrast sensitivity while tear film debris, Schirmer's test, conjunctival and corneal staining score found the non-significant relation with contrast sensitivity. Eventually, we concluded that higher the tear film instability has a more association with worse contrast sensitivity.

Keyword: OSDI, Dry Eye, Cornea, Keratoconus

Introduction

Dry eye disease has been considered the most prevalent condition emerged as a global health problem, recognized by various studies with an estimation of prevalence varies from 30 to 50% at different age groups of the populace.[1] Approximately 5 million people having age 50 years, specifically, women are affected in the United States. Although escalating use of contact lenses and electronic digital devices is an important reason for dry eye disease specifically in the younger generation.[3] A study demonstrated the percentage of dry eye disease symptoms which includes 25% higher school students and 30%-60% office workers.[2] The existing rampant condition of dry eye disorder badly affects the quality of life as well as also created major issues related to corneal and ocular surface that can further cause the infection of the cornea, keratoconus, and contact lens intolerance.[4] Different studies have been defined as dry eye disease in many ways, but their main concept is associated with symptoms having reported prevalence about 20%. The prevalence of morbidity varies with age group, yet it was mostly observed in females. Moreover, this disease not only influences the quality of life but also affect vision.[15] Recently, a study reported the blur vision in 58% of patients with dry eye disease varies from moderate to severe disease.[16] Numerous kinds of research have been reported the reduction of visual function with little evidence in support of dry eye disease causes the deterioration of visual quality of eye.[5]

Antecedent studies approached the fluctuation in corneal function in relation to the superficial punctate keratitis and abnormalities in tear fil related to vision. The substantial decline in visual function, optical quality determined through functional acuity measurement, and contrast sensitivity has an association with central superficial punctate keratitis in dry eye disease.[6] There is also an association with the central corneal ocular surface damaged with greater order aberration and expanded backward light scatter. On the other side irregularity in the optical surface has an association with tear film instability that ultimately affects the vision. Several studies performed research to address the visual function in dry eye disorder for instance high and low contrast visual, dynamic visual acuity,[13,] and contrast sensitivity.[14] The quality of life of a person gets affected when they experienced visual dysfunction and related issues that ultimately create problems in daily life activities.[18] Additional studies are needed to determine the link with visual acuity, contrast sensitivity, and signs of dry eye disease.

Methods

This secondary cross-sectional study was conducted from July 2020 to October 2020 at Teaching Hospital Sialkot. In this clinical trial based study, 243 participants were assessed through screening visit and an eligibility vindication visit, which come up with baseline information required for this analysis. The eligible candidate must show the clinical symptoms of dry eye related to ocular, as appraised from conjunctival (lissamine green) and corneal (fluorescein staining) and Schirmer's test (type I with anesthesia) and age should be at least 18 years with routine screening visit, score on Ocular Surface Disease Index (OSDI) should be in the range from 25 to 80. The OSDI score range from 0 to 100 where 0 score shows the no ocular nuisance. The patients who were taking mediation of dry eye or go through the ocular surgery within the last six months, excluded from the study.

Visual Function Testing

Certified clinicians had performed the visual function test while visual acuity and contrast sensitivity were carried

out with rectification after clear refraction during the baseline visit. However, for the monocular visual acuity test Early Treatment of Diabetic Retinopathy Study Chart (ETDRS) was used, different charts were considered for right and left eye. To reassure the light hitting the chart was 188-377 Lux a light meter was used. Mars Letter Contrast A sensitivity test was performed to measure the contrast sensitivity and kept the 20 inches distance of participant from the chart. The number of alphabets that reads correctly on this chart was changed to a log contrast sensitivity.

Clinical Examination

The clinical assessment and grading of each eye were accomplished through the external examination and biomicroscopy with a slit lamp. The grading for each eye tear film debris included none, mild, moderate, and severe, which indicate the inferior tear meniscus, tear film overlying cornea, and mucus strands on the bulbar conjunctiva. In the sterilized container fluorescein dye (2%) and lissamine, green dye (1%) were inculcated and injected into inferior Cul-de-sac by using the Eppendorf micropipette. Tear break-up time was assessed by following the order of corneal fluorescein staining and evaluation of the Meibomian gland and instill the lissamine green and conduct the interpalpebral conjunctiva staining evaluation. Similarly, repeated the sequential testing for the left eye and measure the intraocular pressure for both eyes along with the Schirmer's test.

After 30 seconds of instillation of fluorescein dye, fluorescein tear breaks up time measured by observed the cornea through a slit lamp under broad beam cobalt blue illumination and by using the yellow barrier filter. The corneal staining was commenced after three minutes of fluorescein dye instillation. The four portions of the central cornea encompassing the corneal surface with superior, nasal, inferior, and temporal broaden to the middle circular zone to the periphery of the cornea. After 2 minutes of accomplishment of lissamine green dye instillation, conjunctival staining commenced. A split lamp with white light was used to observe the temporal and nasal conjunctiva, scoring them from 0 (without staining) to 3 (dense staining). The score from all sections per eye was utilized for staining of cornea and conjunctiva. Although, visual acuity and contrast sensitivity have an association with the staining score of the central corneal. Further, Schirmer's test strips were hung under the conjunctival sac in the temporal one-third of the eyelid then closed the eyes, and after 5 minutes removed the strips and measured the wet length in millimeters.

Statistical Analysis

The statistical calculations were carried out by using the descriptive analysis mean standard deviation. The average values were obtained in the form of OSDI during the screening and visual visit. The concomitant relationship between the visual acuity and contrast sensitivity was appraised by applying the generalized linear model. Herein, visual acuity and contrast sensitivity were deemed independent variables whereas dry eye symptoms were presented as the dependent variable. However, a linear p-value was used for concomitance to interpret the clinical measures.

Eventually, statistically, calculations have proceeded through SPSS version 23, and multiple comparisons were performed to analyze the multiple factors related to dry eyes, visual acuity, and contrast sensitivity. The p-value was computed using the Benjamini Hochberg method.

Results

- Table. 1 represent the 243 participant feature with their mean standard deviation. The mean (SD) age was 57 (12) years, 81 % females, 18 % male, and ocular feature consists of conjunctiva staining score

(0-6) mean (SD) 3.01 (1.4), corneal staining score 0-15) mean (SD) 3.5 (2.7), tear break-up time, sec, mean (SD) 3.4 (1.7), Schirmer test, mean (SD) 9.2 (7.1). Log contrast sensitivity score, mean (SD) 1.6 (0.2), and Visual acuity score, mean (SD) 41.25 (3.05) were recorded.

- The obtained results about the association of visual acuity and contrast sensitivity with dry eye signs does not have significant interaction. As poor visual acuity was not substantially associated with a worse mean score of OSDI including subscale score such as the mean of worse visual acuity 20/32 was 26.3 and 21.5 for better visual acuity 20/16 along with the linear trend p-value 0.92.
- p-values of dry eye symptoms related to visual acuity are shown in Table 3. This data shows that tear film debris and tear break up time were not related to worse visual acuity whereas escalated tear film debris was substantially linked with better visual acuity score with p-value 0.02.
- Herein, Table. 4 shows the connection of dry eye signs with contrast sensitivity. The substantial association of severe Meibomian gland plugging was found with worse mean log contrast sensitivity analysis having score 1.38 for severe and 1.45 for non-plugged with linear trend p-value 0.03. As tear break up time was substantially related with better mean log contrast sensitivity, at TBUT >5, contrast sensitivity 1.47 was measured and 1.41 for tear breakup time >2 seconds. In multiple comparisons both Meibomian gland and tear break up time was studied together that had adjusted the age, refractive error, and cataract status showed a substantial relationship with contrast sensitivity while tear film debris, Schirmer's test, conjunctival and corneal staining score had the non-significant relation with contrast sensitivity.

Table.1 Attributes of participant, n=243, eyes= 486

Participant attributes (patients, n= 243	
Age mean (SD)	56.5 (12)
Gender	
Females	197 (81%)
Males	46 (18%)
Ocular Features, eyes=486	
Conjunctiva staining score (0-6) mean (SD)	3.01 (1.4)
Corneal staining score (0-15) mean (SD)	3.5 (2.7)
Tear break-up time, sec, mean (SD)	3.4 (1.7)
Schirmer test, mm, mean (SD)	9.2 (7.1)
Visual Acuity	
20/16	119
20/20	126
20/25	141
20/32	76

20/40	24
Mean (SD)	41.25 (3.05)
Log contrast sensitivity score, mean (SD)	1.6 (0.2)
Cataract status	
No cataract	306 (62.9%)
Pseudophakic/aphakic	77 (15.8)
Ongoing cataract	104 (21.3%)

Table.2. Mean scores for the Ocular Surface Disease Index (OSDI) by visual acuity score and contrast sensitivity

	Patients (n)	OSDI (Total) mean and Standard error (SE)	OSDI Vision related scale mean, Standard error (SE)
Visual acuity in better eye			
20/16	77	21.5 (1.47)	19.5 (1.82)
20/20	71	22.7 (1.49)	20.1 (1.88)
20/25	69	23.5 (1.49)	21.3 (1.87)
20/32 or worse	26	26.3 (2.37)	23.4 (2.79)
Linear trend p-vale		0.22 (0.43)	0.02 (0.03)
Contrast sensitivity in better eye			
1.71-1.92	93	26.5 (1.43)	20.2 (1.73)
1.54-1.66	52	25.3 (1.64)	21.3 (2.14)
1.42-1.51	60	23.2 (1.54)	19.4 (2.12)
0.83-1.42	38	26.5 (1.89)	23.5 (2.41)
Linear trend p-vale		0.85 (0.85)	0.22 (0.22)

Table.3. linear trend p-value of mean score for visual acuity and contrast sensitivity

Dry eye symptoms	Visual acuity linear trend P-value	Contrast sensitivity linear trend P-value
TBUT (seconds)	0.001	0.02
Schirmer test score	0.98	0.96
Tear film debris	0.02	0.55
Corneal staining score	0.98	0.26
Central corneal staining score	0.07	0.15
Conjunctival staining	0.82	0.04

TBUT= Tear break up time

Table.4. Multiple comparison analysis between visual acuity and contrast sensitivity by signs of dry eye.

Dry eye signs	Eye n=486	Mean (Standard Error)	Linear trend P value
Visual acuity score			
Tear film debris		0.03	
None	319	41.1 (0.30)	
Mild	134	42.3 (0.43)	
Moderate	33	43.0 (0.81)	
TBUT (seconds)		0.008	
>5	57	40.4 (0.77)	
>2 and 5	298	42.7 (0.57)	
2	131	43.3 (0.63)	
Log contrast sensitivity score			
Meibomian gland		0.01	
None plugged	72	1.45 (0.03)	
Mild	147	1.48 (0.03)	
Moderate	158	1.47 (0.03)	
Severe	109	1.38 (0.03)	
TBUT (seconds)		0.009	
>5	57	1.47 (0.03)	
>2 and 5	298	1.45 (0.02)	
2	131	1.41 (0.02)	

TBUT= Tear break up time. This model consists on age, refractive error status and ocular status of cataract, tear film debris.

Discussion

Dry eye imposed detrimental effects on visual activity,[7] our findings obtained from the patients of better visual acuity response better while data from the worse visual acuity has the worse score on the OSDI, negligible score about the dry eye symptoms have not deleterious impact on visual acuity was calculated. Further changes in visual acuity might be because of the difference in tear break-up time and in tear film debris. On the other hand, in a study, contrast sensitivity assessment was greater sensitivity to a distinction based on dry eye symptoms connected to tear film stability, inclusive tear break up time, and Meibomian gland dysfunction as compared to visual acuity measurement. We had evaluated the central corneal fluorescein staining in our study which has a deleterious effect to reduce the visual quality of life especially in patients with other ocular diseases. In small dry eye research on 23 patients explored that central cornea staining strongly affects functional and dynamic visual acuity.[8-9]

In another literature study, ocular diseases namely glaucoma and macular degeneration with age performed high standard contrast visual acuity testing repercussions was unable to do the difference in the state of ocular disease with contrast sensitivity.[10] For instance, patients

are suffering from varying stages of glaucoma have a substantial difference in the mean log contrast sensitivity at the initial and moderate stage.[11] one more study elucidate the mean log contrast sensitivity that was 1.62 for a normal person age 22 to 78 years, exhibit the significantly lesser observations in patients of glaucoma.[12]An investigational study on ocular surface damage in the central cornea found the connection with increasing higher-order aberration and scattering of light by cornea in the backward direction. Tear film instability has an irregular optical surface, strongly affecting the function of the eye.[17]

Conclusion

Long and last of this study provided poor visual acuity rather than worse contrast sensitivity. Although contrast sensitivity measurements are prone to worse tear film stability including treat break up time and Meibomian gland plugging as compared to visual acuity assessments.

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