Original Article

Study of tear film optics and its impact on quality of vision

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Purpose: To evaluate the relation of the tear film on the quality of vision comparing parameters in normal patients to those having dry eye disease. **Methods:** 50 normal and 50 eyes with dry eye disease (DED) were included in the study. Patients were screened for dry eye with Schirmer's test, tear break up time, ocular surface staining, and assessment of meibomian gland disease. Their quality of vision was assessed using the Optical quality analysis system (OQAS). The results of dry eye evaluation were correlated with the parameters on the OQAS especially the mean objective scatter index (OSI). **Results:** Patients with dry eye and unstable tear film were found to have a significantly worse quality of vision and optical scatter ($P < 0.05$). They were also noted to have fluctuation of vision between blinks. **Conclusion:** Tear film optics can have an important bearing on the quality of vision and quality of life. A detailed assessment preoperatively will help improve surgical outcomes and patient satisfaction.

Key words: Dry eye, evaluation, optical quality, vision

The tear film is an important contributing factor to the complex optical system of the eye as the tear film–air interface is the first refractive surface through which the light travels to reach the retina. The outermost lipid layer of the tears reduces the breakdown and evaporation of the tear film between each blink thus stabilizing it.[1] This is very important as evaporation of the tear film between each blink can cause transient aberrations and reduced optical quality of the image.[2] A good tear film reduces the scattering of light and helps in partially correcting optical aberrations occurring due to irregularities on the ocular surface.

Dry eye disease (DED) is a condition in which there is a compromise of the quality or production of tears and inflammation of the ocular surface resulting in variable symptoms including ocular fatigue, irritation, burning sensation in the eyes, visual disturbance or fluctuating vision.[3] Due to the loss of tear film homogeneity in this condition, there is a variation of the refractive index at the air-tear film interface, increase in scattering of light entering the eye, generation of aberrations, and finally a distorted retinal image.[4] Assessment of the visual quality and the tear film ocular surface are therefore interconnected. There are different methods to assess the tear film and two of the most common methods include the Schirmer's test and tear film break-up time (TBUT).[5,6] The impact of tear film variations on the visual quality would need a noninvasive assessment which takes into account the fact that the tear film is dynamic and affected by blinking and eye movement. The Optical Quality analysis system (OQAS, Visio metrics S.L, Terrassa, Spain) is a real-time non-invasive test developed to perform an objective evaluation of optical vision quality. It works on the double pass principle and allows the objective quantification of intraocular scattered light.[7] As DED can cause significant morbidity by hampering a patient's activities of daily living and has an economic impact on the individual and the community, it is important to assess this in detail.[3,8]

The aim of this study was to evaluate the impact of the tear film on quality of vision in normal patients versus those having dry eye disease. The tear film can be affected by various ocular surgical procedures like refractive surgery, hence, evaluating the tear film adequately is essential to provide good postoperative visual outcomes to our patients.[9]

Methods

This is a prospective study of 100 eyes to compare the optical quality of the tear film in normal individuals versus patients diagnosed with dry eye disease (evaporative or aqueous deficient). The study was carried out as per the guidelines by the Declaration of Helsinki and was approved by the institutional ethics committee. 50 eyes of 25 patients diagnosed with dry eye disease (group 1) and 50 eyes of 25 normal subjects (group 2) were evaluated for their optical vision quality. Participants in both groups were age and gender matched with best spectacle-corrected visual acuity (BCVA) 6/12 or better with no history of ocular trauma, ocular surgery or systemic illness.

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Examinations

The participants underwent visual acuity testing and refraction followed by a detailed slit lamp examination to rule out any other ocular conditions which could confound results. The dry eye evaluation included Schirmer's test (with and without topical anesthesia), tear film break-up time (TBUT) and corneal staining with fluorescein dye. The analysis of visual function was done on the Optical Quality Analysis System (OQAS). The visual quality evaluation was done first and followed by the dry eye evaluation. Patients who were on lubricant eye drops were advised not to instill the medications for at least 2 hours before the tests.

Schirmer's test was performed using the Schirmer's test strip and the results were noted at 5 minutes after placing the strip in the eye. This was followed by the TBUT test by instilling sodium fluorescein dye into the lower fornix, asking the patient to blink and then watch for the first area of break in the tear film which is taken as the tear break up time. 3 readings of TBUT were done to improve the reliability of results. Patients were divided into dry eye and normal subjects based on these tests. Patients with either Schirmer's (without anesthesia) value <10 mm at 5 minutes or TBUT test < 8 seconds were diagnosed as DED.[3] Patients having lid abnormalities, corneal opacities or scarring were excluded from the study. None of the patients had any ocular surgery prior to this evaluation.

Optical quality analysis

The optical quality of the tear film and visual quality were measured using the Optical Quality Analysis System (OQAS, Visiometrics SL, Spain). Objective refraction of the patient was entered in the system prior to the examination to achieve the best focus. The double- pass technique is based on recording images from a point source after reflection in the retina and a double pass through ocular media.[7] It assesses the ocular scatter and the effect of higher-order aberrations on the light entering the eye thereby providing a measure of the optical visual quality.[7] As the machine assesses the optical quality of the tear film in 0.5 s intervals, it gives real-time measurements of the effects of changes in tear film on optical quality. This allows a measurement of the visual quality in between each blink, which is correlated with the potential visual acuity at each time point [Fig. 1]. Parameters used to measure the visual quality include Objective Scatter Index (OSI), modulation transfer function (MTF) which were calculated at an artificial pupil size of 4 mm. The tear film analysis program of OQAS records dynamic changes of the objective scatter index (OSI) values and calculates the mean value of the OSI over 20 s and it's standard deviation (Mean OSI). Mean OSI is only due to tear film alterations. This test therefore is useful for analyzing patients who have fluctuating vision and correlating this to their tear film and dry eye related changes.[10,11]

The test has been shown to have good repeatability and reproducibility for objective measurements of overall optical quality in normal and dry eye patients.[12,13]

Results

This study compared the visual quality using the optical quality analysis system (OQAS) in 50 eyes of patients with DED (Group 1) to 50 eyes in patients who are normal (Group 2). The patients were age and gender matched in both groups. The age range for both groups was 25-40 years. There were 35 females and 15 males in both group 1 and 2. There were no contact lens users among the subjects and none of them had undergone any ocular surgery. Detailed slit lamp examination of all 50 subjects was done at screening to look for any ocular infections, lid abnormalities, ocular surface scarring, corneal opacities, non-dry eye-related inflammation or signs of ocular surgery which were exclusion criteria for the study.

In group 1 (DED), all 50 eyes had low TBUT or Schirmer's value or both as defined previously thus classifying them as aqueous deficient or evaporative dry eye. They were also graded as per the severity of disease and any staining or obvious irregularity of the corneal surface was noted. All the patients in group 1 had mild to moderate dry eye disease. 16 of 25 patients in group 1 had vision-related symptoms as well. Other causes for visual complaints were ruled out by a detailed refraction, corneal topography, lenticular and retinal examination. None of the eyes in group 2 control eyes had low TBUT or low Schirmer's values. The average TBUT among the patients in group 1 was 5.5 seconds with a range of 2 to 7 seconds and the average Schirmer's values was 8 mm as compared to an average TBUT 9 of and an average Schirmer's value of 25 in group 2. The ocular surface disease index (OSDI) score was also significantly higher in the group 1 ($p < 0.05$) compared to the control group. None of the patients had corneal staining within the visual axis or other severe corneal changes like filaments, scarring or thinning which could confound results of the visual quality analysis. The mean OSI of patients in both groups was calculated and was 9.50 in group 1 and 0.69 in group 2. This shows a significantly higher optical scatter in patients with dry eye as compared to the normal eyes ($p < 0.05$). The fluctuation in vision quality between blinks was also noted and found to be much higher giving a saw tooth like pattern in patients with poor tear film quality. An inverse association was noted between both TBUT and schirmer's values and the OSI [Fig. 2]. This implies that DED (aqueous deficiency or evaporative) in a patient is associated with relatively poorer quality of vision and there is also a significant deterioration of quality of vision with worsening DED test values.

Statistical analysis

The analysis of the data was done using *MedCalc Version* 19.4.1. All parameters were assessed for normality of distribution. Continuous variables were tested using difference in their mean/median. Correlation between the dry eye parameters and those of optical quality were analyzed. Spearman's correlation was done to evaluate the correlation between the dry eye test values (Schirmer's and TBUT) in patients and the optical quality as defined by their OSI values from the OQAS.

Discussion

An adequate assessment of a patient's vision should include a measurement of the quality of vision and not just the visual acuity assessment on high contrast charts like the Snellen's visual acuity chart. A patient who has good visual acuity may still have other vision-related problems including fluctuating vision or loss of contrast. DED patients may have these complaints in addition to the more common symptoms like ocular discomfort, pain or ocular fatigue.[11,14,15]
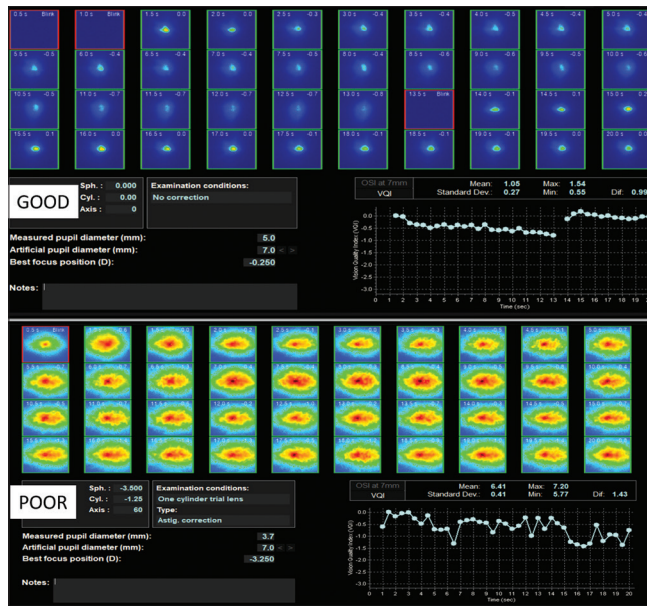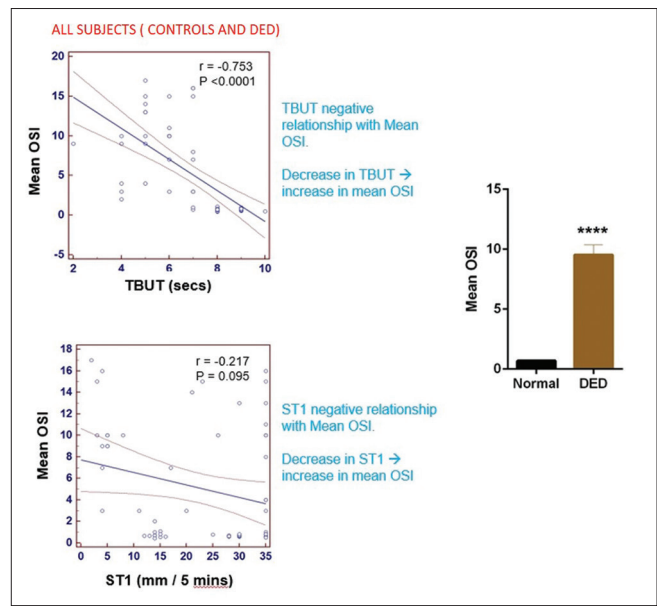
Figure 1: Representative image of tear film analysis with OQAS. Objective scatter index value change over a time period and blinks noted. The graph that shows the OSI change over 20 seconds. Upper image is a good tear film, and lower a poor tear film

Figure 2: Graphs showing the correlation between dry eye test values and the objective scatter index (OSI) demonstrating the negative relation between dry eye test values and OSI. The bar diagram shows a significant association between the dry eye and OSI

The reason for these visual symptoms is that an unstable tear film results in increased higher order aberrations after the blink and a consequent fluctuation of vision. The person can also complain of glare due to the scattering of light. As they try to accommodate to improve visualization in spite of this poor tear film, they can develop excessive ocular fatigue as well.[16]

Poor visual quality can also have an impact on the quality of life of these patients.[17] It is important to evaluate subjective symptoms and quality of life scores when assessing the severity of DED. Assessment of the quality of vision therefore plays an important role in our approach to manage and treat these patients.[18] This also helps us provide satisfactory postoperative treatment outcomes to patients. The OQAS is a useful tool in measurement of the optical quality of a patient's vision.

In our study we found a good correlation between the values of the dry eye tests and the optical scatter index (OSI). An inverse relation between the 2 implies a worsening of the quality of vision with severity of DED. This is similar to findings shown in other studies which also measured optical quality in patients with fluctuating vision due to dry eye and found that dry eye and a poor ocular surface can significantly contribute to a poorer optical quality in a person.[11,18-20] As the test has good repeatability it can also help in assessment and planning of therapy for dry eye and following up the patient's recovery once therapy is initiated.[12,13,21] Objective Scatter Index (OSI) quantifies the degree of dispersion in the optical system. Parameters on the OQAS such as objective scatter index (OSI) and mean OSI, modulation transfer function (MTF) and Strehl's ratio have shown good repeatability and reproducibility even in dry eye patients.[22,23] Newer parameters like noninvasive break-up time (NIBUT) and vision break up time (VBUT) are also useful in following up response to therapy in these patients. As dry eye can occur postoperatively in refractive surgery and cataract surgery as well and is a cause of postoperative dissatisfaction, it is important to adequately assess these patients preoperatively to obtain predictable outcomes.[24-26] Therefore this assessment provides the necessary information to help both the doctor and the patient understand the underlying condition better and customize treatment.

Conclusion

The quality of vision is an important determinant of a person's quality of life as it has an impact on all our activities. Conditions like DED can affect the quality of vision, hence it is important to measure this when assessing a patient of dry eye if they have significant vision-related symptoms. This could also help in quantifying the severity of the condition and assessing the effect of therapy in ameliorating symptoms and signs. Our study assesses the effect of dry eye disease on the optical quality. The known effect of ocular surgeries especially refractive surgery on the ocular surface further emphasize the need to do a detailed preoperative evaluation of visual quality in these patients for better outcomes.

Conflicts of interest

There are no conflicts of interest.

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