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Effect of Ramadan Fasting on Keratometry Readings and Tear Film Stability: Implications for Refractive Surgery Planning

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Abstract

Background: Ramadan fasting is accompanied by physiologic changes which can affect tear film parameters and corneal parameters. Fasting induced changes effect factors like keratometry and tear film stability are significant factors that are needed in refractive surgery planning.

Objective: To assess the keratometry and tear film stability changes during fasting and their implications for surgical planning.

Methodology: The is quasi-experimental study was carried out in the Eye OPD of Chaudhary Muhammad Akram Hospital on 50 healthy fasting subjects aged 20-25 years. Ocular parameters were measured with and without fast. Keratometry readings (K1 and K2), Tear Break Up Time (TBUT) and Schirmer's test were performed. Data were analysed with SPSS version 25 and Wilcoxon signed rank test was applied to compare the measurements.

Results: The study showed a significant rise in the corneal curvature in fasting period. Mean K1 increased from 42.37 ± 1.13 D to 43.15 ± 1.07 D during non-fasting and fasting ($p < 0.001$), while mean K2 increased from 43.01 ± 1.08 D to 43.62 ± 1.06 D($p < 0.001$). Fasting had a significant effect on decreasing the tear film stability, as indicated by a decrease in TBUT from 11.46 ± 3.97 seconds to 10.74 ± 4.51 seconds($p = 0.020$). Also Schirmer's test values significantly reduced on fasting($p < 0.001$).

Conclusion: The fasting period during Ramadan appears to have a profound impact on the cornea and tear film stability, potentially impacting on the planning of refractive surgery and the accuracy of the ocular biometry.

Keywords: Corneal Curvature, Fasting, Refractive Surgery

Introduction

The precision and stability of measurements made before refractive surgery, such as keratometry, corneal topography, and tear film evaluation, are vital to the success of refractive surgery outcomes. A stable tear film and a healthy corneal surface are critical to getting good biometric readings and best post-op visual outcomes [1]. Small changes in ocular surface parameters can impact corneal geometry for laser ablation planning, intraocular lens calculations, and postoperative patient satisfaction. Hence, the recognition of the physiological factors that can temporarily influence the measurement of the eye is relevant in the planning of refractive surgery [2].

Millions of Muslims around the world fast during Ramadan; which is held every year and lasts for about a month of abstinence from food and fluids from dawn until sunset. Length of fast can vary by geographic region and season; it may be for long periods and may involve dehydration, changes in sleep cycles, and changes in metabolism [3]. These systemic changes can affect the physiology of the eyes, including tear film, corneal hydration and anterior segment parameters [4]. In Muslim community where refractive surgery is rapidly becoming a frequent practice, knowledge of changes in the eye during fasting is becoming more relevant to ophthalmologists and refractive surgeons [5.]

A few studies have shown that during the Ramadan fast, tear film stability and ocular surface health could be negatively affected [6,7]. During fasting, reduced Schirmer test values, decreased tear breakup time (TBUT), increased tear osmolarity and worsening of dry eye symptoms have been reported [8,9]. There was also an increase in some inflammatory markers on the ocular surface, such as matrix metalloproteinase-9 (MMP-9), indicating sub clinical ocular surface inflammation during prolonged fasting [10]. The changes may have implications for the time of refractive surgery, as dry eye disease and tear film instability are identified risk factors of inaccurate keratometric readings and poor refractive surgical outcomes [11].

Apart from the changes in tear film, fasting during Ramadan might have an impact on corneal and biometric measurements [12]. While some studies showed no changes in refractive error and minimal changes in mean keratometry, some other studies showed transient changes in corneal curvature, anterior chamber depth, axial length and intraocular lens power calculations during fasting periods [13]. Such changes are believed to be due to a shift in corneal hydration status and ocular biomechanics, as a consequence of dehydration [14]. Even slight anatomic differences can result in improper refractive targets, or a suboptimal surgical plan, particularly in high-precision surgeries, like LASIK, PRK, or topography-guided surgeries [15].

Despite the increasing evidence of changes in the eye during Ramadan, the literature is still limited and uncertain. Different study designs, environmental factors, time of assessment and assessment tools result in varying findings. Moreover, the most studies have been done on normal subjects and not on patients who are interested in refractive surgery. There is a lack of data on the effect of tear film instability in conjunction with keratometric changes on refractive surgery planning and post-surgical visual quality during Ramadan fasting. The aim of the present study was to assess the influence of Ramadan fasting on keratometry readings and tear film stability and its consequences on refractive surgery planning. Knowledge of these changes linked to fasting may guide clinicians to consider the best times for measuring eyes before surgery, better manage the eyes during surgery, and ultimately improve accuracy in surgeries and the ocular surface in fasting patients.

Methodology

This Quasi Experimental study was conducted at designated Eye OPD / Clinical Facility at CMA (Chaudhary Muhammad Akram Hospital). The study was conducted pre-Ramadan and last week of Ramadan phases. This Sample size was estimated 48 patients using the level of significance 5%,

power of test 80%, 1st mean is 43.03, 2nd mean is 42.24, and standard deviation is 1.34 taken from previous study, the sample size is computed using the formula below:
n=σ2(Z1−α+Z1−β)2
(μ1−μ2)2
where,
Level of significance (Zα/2) = 5% = 1.96
Power of test (Zβ) = 80%
Level of significance (Zα/2) = 5%= 1.96
Power of test (Zβ) = 80%
1st Mean (μ1)= 43.03 2nd Mean (μ2)= 44 [15]
Standard deviation (σ) = 1.34
Non-Probability Convenience Sampling Technique was used to collect data.Individuas between age 19–40 years, with healthy cornea on examination, no previous history of ocular surgery individuals, stable refraction, not using contact lenses (minimum 2 weeks prior) and willing to fast during Ramadan were included in the study while diagnosed dry eye disease patients, with corneal diseases (keratoconus, scarred corneas, corneal dystrophies) and refractive/corneal surgery, individuals who have other medical conditions that affect the tear film (diabetes, autoimmune conditions), pregnant or lactating patients and individuals using topical eye drops or systemic medications affecting tear secretion were excluded from the study.The rules and regulations set by the ethical committee of Superior University Lahore were followed while conducting the research and the rights of the research participants were respected.Written informed consent (attached) was taken from the participants. Participants meeting the inclusion criteria were recruited for a baseline assessment one week prior to Ramadan (non-fasting) and a follow-up assessment during the final week of the fasting period. To ensure data consistency and control for diurnal variation, all clinical measurements were strictly conducted between 14:00 and 16:00. The examination protocol was follow a standardized sequence to maintain measurement integrity, beginning with a visual inspection of the ocular surface via slit-lamp biomicroscopy. This was followed by automated keratometry to record steep (K1) and flat (K2) corneal curvatures using a calibrated instrument. Tear film stability was then assessed using the Tear Break-Up Time (TBUT) test, involving the instillation of fluorescein dye and observation under a cobalt blue filter.Subsequently, aqueous tear production was quantified via the Schirmer's test, using standardized filter paper strips placed in the lower conjunctival fornix for five continuous minutes.To ensure high reliability and minimize measurement error, three consecutive readings were be recorded for each parameter, and the arithmetic mean was utilized for the final statistical analysis.
All the collected data were entered and analyzed with Statistical Package for Social Sciences (SPSS) version 26. Demographic characteristics and study variables were summarized using descriptive statistics such as mean, standard deviation, frequency and percent. The normality of data was checked by Shapiro–Wilk test. The majority of the variables were not normally distributed ($p<0.05$) so non-parametric tests were used for inferential analysis. For the comparison of various corneal and tear film parameters between fasting and non-fasting state, Wilcoxon Signed Rank Test was used. The significance of the p value was set at ≤ 0.05.

Results

This study was conducted on 50 individuals. The average was 21.80 ± 1.54 years, with a range of 20 to 25 years. The normality of data was assessed in Table No. 1, using a statistical test, the Shapiro-Wilk. The results showed that most of the variables are significantly different from the normal distribution with a p-value less than 0.05. So, it is justified to use non-parametric statistical methods in the later analyses. Out of the total, there were 16(32%) were females, and 34(68%) were male participants in this study.

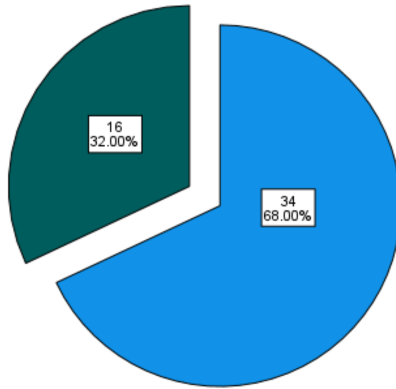

Figure 1: Gender Distribution of Study Participants

Table No. 2 shows statistically significant differences by using the Wilcoxon Signed Rank Test to compare the ocular parameters between fasting and non-fasting phases. The average K1 readings were higher in the fasting phase (43.15 ± 1.07 D) than in the non-fasting phase (42.37 ± 1.13 D) with a highly significant p-value (<0.001). The same was also true for the K2 measurement, which was higher during the fasting state (43.62 ± 1.06 diopters) than during the non-fasting state (43.01 ± 1.08 diopters) with statistical significance (p < 0.001). The TBUT, a measure of tear film stability, did not significantly change during fasting (10.74 ± 4.51 seconds), but was significantly less than in non-fasting (11.46 ± 3.97 seconds, p = 0.020). Moreover, there was a significant difference between both the fasting (15.62 ± 7.57 mm) and non-fasting (19.04 ± 8.67 mm) tear volumes with the level of significance being highly significant (p < 0.001).

Table 1: Comparative Analysis of Corneal and Tear Film Parameters in Fasting and Non-Fasting Phases

Variables	**Fasting**	**Non-Fating**	**P-values**
	Mean ± SD		
K1(diopters)	43.15 ± 1.07	42.37 ± 1.13	<0.001
K2(diopters)	43.62 ± 1.06	43.01± 1.08	<0.001
TBUT(sec)	10.74 ± 4.51	11.46 ± 3.97	0.020
Schirmer's Test(mm)	15.62 ± 7.57	19.04 ± 8.67	<0.001

Figure No. 2 shows the mean values of corneal and tear film parameters in fasting and non-fasting groups. Both K1 readings (purple line) and K2 readings (green line) showed a small increase from fasting to non-fasting, indicating that corneal curvature is steeper during fasting. Conversely, the tear film parameters exhibit an inverted pattern. TBUT (dark pink line) and Schirmer's Test (red line) are both elevated in the non-fasting period as opposed to the fasting period, suggesting improved tear film stability and secretion in the non-fasting period. Overall, the graph illustrates a physiological difference between the two stages. Fasting increases corneal steepness and decreases the function of the tear film, while non-fasting conditions favour a more stable and copious tear production.

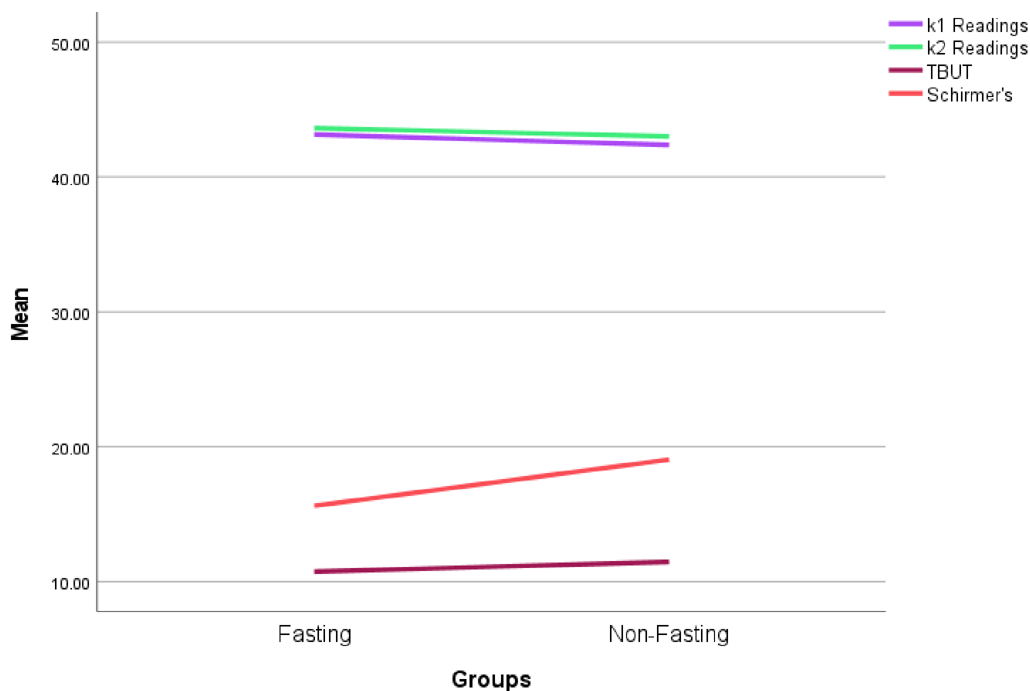

Figure 2: Impact of Fasting on Corneal Curvature and Tear Film Parameters

Discussion

The aim of the present study was to compare the effect of Ramadan fasting on keratometry readings and tear film stability and its implications for refractive surgery planning. The results indicated that there was a significant difference between the parameters of the tear film and the corneal curvature in the fasting state and the non-fasting state. The results suggest that these changes in physiological parameters that happen in the fast can impact eye parameters such as K1,K2 and TBUT used in clinical ophthalmology.

The present study revealed that there was a significant increase in the corneal curvature during the Ramadan fast as compared to non-fasting period and that the K1 value during the fasting period was higher than the non-fasting period ($p<0.001$); while the K2 value during the fasting period was also higher than the non-fasting period ($p<0.001$). Anam et al. also reported similar readings, and found that the mean K1 increased significantly from 42.24 D in the non-fasting state to 43.03 D during fasting, while mean K2 also showed a significant increase from 43.28 D to 43.87 D during fasting ($p < 0.05$).The similarities reported here by Anam et al. could be explained by the fact that the cornea has been dehydrated and the changes in its hydration status during prolonged fasting[15]. Some differences between these studies and the present study might also be attributed to the differences in age, environmental temperature, hydration status, fasting length and keratometric measurement methods [2]

The present study also showed that the fasting period (10.74sec ± 4.51) resulted in a statistically significant decrease in TBUT as compared to non-fasting (11.46 sec ± 3.97; p=0.020). Alomari et al. reported decrease in the tear film stability and increased ocular dryness during Ramadan fasting, which may be attributed to the decreased fluid intake and increased tear evaporation during the fasting period.[7] Similarly, Armstrong et al. reported that during the fasting period there was a decrease in TBUT from 7.0 to 5.3 seconds [12].

In terms of tear secretion, the values obtained from the Schirmer test were significantly lower on

fasting than on non-fasting (15.62mm ± 7.57 and 19.04mm ± 8.67 respectively; $p<0.001$). The same results were reported by Koktekir et al., who observed a significant decrease in Schirmer values during fasting whereas the mean Schirmer I values were 14.8mm ± 6.0 and 10.6mm ± 5.3 in nonfasting and fastin periods, respectively.[4] Armstrong et al. also reported a decrease in tear production during fasting, but the change was not statistically significant.[12] These results confirmed the evidence that fasting has a negative effect on tear production and lubrication of the ocular surface.[16]

In the current study, the corneal steepening and changes in tear film parameters observed support the suggestion that the fasting period could affect parameters related to eye biometrics as well as tear film physiology, which is corroborated by the systematic review conducted by Daryabari et al. that observed decreased basal tear secretion, increased tear osmolarity and decreased TBUT following Ramadan fasting in some populations.[4]

From a clinical standpoint, these findings are significant as they can impact the planning of refractive surgery and calculations of intraocular lenses.[17] Hence, the status of fasting needs to be considered during Ramadan to evaluate corneal and tear film values.

There are some limitations of the study.This research has a relatively small number of participants (N=50) which might restrict the generalizability of the results. The study also did not include advanced diagnostic techniques like corneal topography, tomography, tear osmolarity, and lipid layer analysis. The current study took place in a single clinical center, which might be a factor in the non-generalizability. Moreover, It is best to see refractive surgery patients at non-fasting times or after proper hydration to take more accurate keratometric refraction readings. Before refractive surgery, particularly during Ramadan, the physician should routinely evaluate the tear film stability.For more reliable keratometry and tear film measurements, fasting is recommended, and measurements will be repeated. Education should be provided for patient regarding the hydration requirement of the eye during non-fasting hours and avoid excessive screen time to keep ocular surface stable.

Conclusion

In conclusion, It was revealed that fasting has a significant association with steep corneal curvature (K1 and K2 readings) and decreased tear film function (TBUT and Schirmer's Test values). These physiological changes highlight the measurable impact of fasting on eye health. Moreover, the demographic profile of the participants, with a higher proportion of males (68%), is important for understanding these findings. In aggregate, the findings emphasise the significance of accounting for fasting status and participant characteristics in clinical assessments, highlighting the importance of evidence-based approaches, and patient care in ocular research and practice.

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