*Research Article / Araştırma Makalesi*

# Diurnal Changes in Accommodation Amplitude and Anterior Segment Parameters During Ramadan Fasting

## Akomodasyon Amplitüdü ve Ön Segment Parametrelerinde Ramazan Orucu Sırasındaki Diürnal Değişimler

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**Abstract**

**Background:** The purpose of this research was to investigate the diurnal effect of Ramadan fasting on the amplitude of accommodation and anterior segment parameters in visually healthy participants.
**Materials and Methods:** The study included 68 healthy individuals, aged 26–42 years. The subjective accommodation amplitude was measured using the "minus lens" technique. Corneal refraction (K1, K2, and Kmax), central corneal thickness, corneal volume, anterior chamber volume, and anterior chamber depth parameters were evaluated using the Scheimpflug camera system. Participants were evaluated twice, at 08:00 and 16:00, while fasting during Ramadan. Data were analyzed by paired sample t-test.
**Results:** The mean age of the participants, of which 28 were women and 40 were men, was 34.38±4.93 (range: 26–42). Comparison of measurements taken at 08:00 and 16:00 during fasting showed that at 16:00, the K1 values (08:00: 42.81±1.51 diopter and 16:00: 42.85±1.50 diopter, P = 0.016) and Kmax values (08:00: 44.29 ± 1.73 diopter and 16:00: 44.38±1.78 diopter, P = 0.020) were significantly steeper. When data collected at 08.00 and 16.00 were compared, there were no significant differences in diurnal changes: amplitude of accommodation (08:00: 7.39±1.40 diopter and 16:00: 7.37±1.40 diopter, P = 0.783), central corneal thickness (08:00: 535.60 ± 30.43 µm and 16:00: 535.25±30.66 µm, P = 0.694), corneal volume (08:00: 59.72±3.85 $mm^3$ and 16:00: 59.60±3.98 $mm^3$, P= 0.344), anterior chamber volume (08.00: 170.91±30.77 $mm^3$ and 16.00: 171.22±32.61 $mm^3$, P = 0.808) and anterior chamber depth (08:00: 2.91 ± 0.28 mm and 16:00: 2.92 ± 0.29 mm, P = 0.053).
**Conclusions:** The results showed that dehydration due to fasting affects some anterior segment parameters, such as corneal refraction; however, it does not affect the diurnal changes of amplitude of accommodation, corneal pachymetry, or anterior chamber anatomy.

**Key Words:** Amplitude of accommodation, Anterior segment parameters, Diurnal change, Minus lens technique, Ramadan fasting

**ÖZ.**

**Amaç**: Çalışmamızda görsel olarak sağlıklı olgularda Ramazan orucunun akomodasyon amplitüdü ve ön segment parametreleri üzerine olan diürnal etkisini değerlendirmeyi amaçladık.
**Materyal ve Metod:** Subjektif akomodasyon amplitüdü, "eksi lens" tekniği kullanılarak ölçüldü. Korneal kırıcılık (K1, K2 ve Kmax), santral kornea kalınlığı, kornea hacmi, ön kamara hacmi ve ön kamara derinlik parametreleri ise Scheimpflug kamera sistemi kullanılarak değerlendirildi. Gönüllülerin değerlendirmeleri Ramazan ayı içerisinde oruçlu iken sabah saat 08:00 ve öğleden sonra saat 16:00 olmak üzere iki kere yapıldı. Veriler eşleştirilmiş örneklem t testi ile analiz edildi.
**Bulgular:** Yirmi sekizi kadın, 40'ı erkek olan olguların yaş ortalaması 34.38±4.93 (26-42) idi. Oruç sırasında saat 08.00 ve 16.00 ölçümlerini karşılaştırdığımızda, saat 16:00'da K1 (08:00: 42.81 ± 1.51 dioptri ve 16.00: 42.85±1.50 dioptri, P= 0.016) ve Kmax (08.00: 44.29±1.73 dioptri ve 16.00: 44.38±1.78 dioptri, P = 0.020) değerlerinin anlamlı şekilde daha dik olduğunu gözlemledik. Saat 08.00 ve 16.00 ölçümleri karşılaştırıldığında akomodasyon amplitüdünün (08:00: 7.39±1.40 dioptri ve 16:00: 7.37±1.40 dioptri, P= 0.783) santral kornea kalınlığının (08:00: 535.60±30.43 µm ve 16.00: 535.25 ± 30.66 µm, P= 0.694), kornea hacminin (08.00: 59.72±3.85 $mm^3$ ve 16.00: 59.60±3.98 $mm^3$, P = 0.344), ön kamara hacminin (08.00: 170.91±30.77 $mm^3$ ve 16.00: 171.22±32.61 $mm^3$, P= 0.808) ve ön kamara derinliğinin (08.00: 2.91±0.28 mm ve 16.00: 2.92±0.29 mm, P= 0.053) diürnal değişikliklerinde anlamlı farklılık olmadığı saptandı.
**Sonuç:** Sonuçlarımız oruca bağlı dehidratasyonun gözün korneal kırıcılık gibi bazı ön segment parametrelerini etkilediğini göstermekle birlikte akomodasyon amplitüdü, kornea pakimetresi ve ön kamara anatomisinin diürnal değişimlerini etkilemediğini ortaya koymaktadır.

**Anahtar kelimeler:** Akomodasyon amplitüdü, Ön segment parametreleri, Diürnal değişim, Eksi lens tekniği, Ramazan orucu

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## Introduction

Muslims abstain from eating, drinking, and smoking at their own caution amid the month of Ramadan. This fasting period influences the human body, both mentally and physically (1-3).

Various papers have already documented the impacts of fasting on the following features and processes of the front and back structures of the human eye (4-9): refraction, tear secretion and ocular surface, corneal and anterior chamber parameters, intraocular pressure, choroid thickness, retinal nerve fiber layer thickness, and retinal vessel density. There is little research regarding the effects of fasting on the functional visual system. Additionally, most of the studies mentioned above did not evaluate the structural and functional parameters of the eye diurnally.

The amplitude of accommodation can be defined as the amount of accommodation the eye makes when moving from focusing on a distant point to focusing on a near point. The amplitude of accommodation can be measured by objective or subjective methods. Objective methods require a device such as a refractometer, autorefractometer, or videorefractometer (10, 11). The "minus lens" technique is one technique used for the subjective assessment of accommodation amplitude (12).

It has been shown that people who fast are more likely to feel dehydrated, and diurnal changes seen during the day may become more pronounced during fasting (2, 13, 14).

In the present study, the primary aim was to evaluate the effect of Ramadan fasting on the amplitude of accommodation and anterior segment parameters in visually healthy participants.

## Materials and Methods

This retrospective, observational, and cross-sectional study included 68 healthy participants (28 women and 40 men, aged 26–42 years), who presented with refractive error suspect and had no ocular pathology. The research protocol adhered to the provisions of the Declaration of Helsinki. Approval was obtained from the Ethics Committee of Diyarbakır Gazi Yaşargil Training and Research Hospital (decision date: 28 June 2019, No. 307). Informed consent was obtained in written form from every participant included in the study.

Regarding the inclusion criteria, only those individuals with the following characteristics were included in the study:

(1) Over 18 years of age.
(2) Fasted during the Ramadan period between 6 May 2019 and 3 June 2019.
(3) Best-corrected visual acuity (BCVA) ≥ 20/20.
(4) A cylindrical error and spherical error of <1.0 diopter and <+3.0 or >−3.0 diopters, respectively. Refractive error was measured without cycloplegia. The spherical equivalent measurement was made by adding half of the cylindrical error to the spherical error.
(5) No acute or chronic systemic disorders (diabetes mellitus, systemic hypertension, autoimmune illness, etc.).
(6) Had not undergone ocular laser or surgical therapy or any kind of intraocular surgery, including cataract extraction.

Participants with current or previous ocular diseases (strabismic visual disorders, dry eye, etc.) were excluded. Those using topical and systemic drugs or wearing contact lenses were also excluded.

An ophthalmic examination was performed on all participants and included BCVA, anterior segment and fundus examination, and refraction using an autorefractor (KR-890; Topcon Corporation, Tokyo, Japan).

Participants were evaluated twice, at 08:00 and 16:00, while fasting during the third week of Ramadan.

The subjective accommodation amplitude (diopter) was measured monocularly using the minus lens technique (12). The same trained examiner evaluated the accommodation amplitude; this method has been used in many studies in the literature. All measurements were made in a single room with the same lighting and air conditioning conditions. After a participant's far refraction was corrected, they were asked to focus on the N8 target that consisted of Snellen letters at a distance of 40 cm. Later, negative lenses were added to the subjective refractive correction value in increments of 0.25 diopter. Each time a lens was added, individuals were allowed 5–10 seconds to clarify the letters. At each stage, participants were also asked to try their best to see the object clearly. The total value was recorded at the point when the letters were constantly blurred for the first time. The end point was the moment when the target appeared to be constantly blurred. The total accommodation amplitude was determined as the sum of +2.50 diopter (dioptric equivalent of working distance) plus the minus lens power added to the total.

Tomographic evaluations were performed using elevation maps obtained from the rotating Scheimpflug camera system (Pentacam High Resolution, Oculus Optikgeräte GmbH, Wetzlar, Germany). The same technician performed all the Pentacam measurements. Pentacam measurements were taken automatically when the participant's chin and forehead were correctly placed, eyelids were open wide, and focus was on the fixation point. All Pentacam measurements were obtained in a specific location with fixed lighting (darkened setting) and air conditioning conditions.

Corneal front surface keratometry (K) (K1, K2, and Kmax; diopter), central corneal thickness (µm), corneal volume ($mm^3$), anterior chamber volume ($mm^3$), and anterior chamber depth (mm) parameters were evaluated using the Scheimpflug camera system.

Data from right eye measurements only were included in the analysis.

***Statistical analysis***

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 20.0 (SPSS Inc., Chicago, IL, USA). Continuous variables were expressed as mean ± standard deviation and categorical variables as count (frequency). The Shapiro–Wilk test was used to check the normality of the sample distribution. The chi-square test was used to compare categorical variables. The intraclass correlation coefficients (ICCs) were used to evaluate intraobserver reliability, and the ICC was calculated by comparing two measurements obtained at the same location by a single operator. ICCs less than 0.50 were considered poor, those between 0.50–0.75 moderate, those between 0.75–0.90 good, and those greater than 0.90 excellent (15). A paired sample t-test was used in 08:00 vs. 16:00 comparisons. The results were evaluated at a 95% confidence interval and an accepted significance level of P < 0.05.

## Results

The study included 40 male (59%) and 28 female (41%) participants and the examination of 68 eyes. The mean age of participants was 34.38 ± 4.93 years (range: 26–42). The study was conducted at the Department of Ophthalmology in Diyarbakır Gazi Yaşargil Training and Research Hospital during the third week of Ramadan in 2019 (6 May to 3 June). Hence, the study was conducted in the summer in a hot climate.

The BCVA of all participants was 20/20 and the mean spherical equivalent was −0.37 ± 0.61 diopters.

A comparison of measurements taken at 08:00 and 16:00 during fasting showed that at 16:00, the K1 values (08:00: 42.81 ± 1.51 diopter and 16:00: 42.85 ± 1.50 diopter, P = 0.016) and Kmax values (08:00: 44.29 ± 1.73 diopter and 16:00: 44.38 ± 1.78 diopter, P = 0.020) were significantly steeper. However, when the values obtained at 08:00 and 16:00 were compared, there were no significant differences in the diurnal changes of the amplitude of accommodation (08:00: 7.39 ± 1.40 diopter and 16:00: 7.37 ± 1.40 diopter, P = 0.783), central corneal thickness (08:00: 535.60 ± 30.43 µm and 16:00: 535.25 ± 30.66 µm, P = 0.694), corneal volume (08:00: 59.72 ± 3.85 $mm^3$ and 16:00: 59.60 ± 3.98 $mm^3$, P = 0.344), anterior chamber volume (08:00: 170.91 ± 30.77 $mm^3$ and 16:00: 171.22 ± 32.61 $mm^3$, P = 0.808) and anterior chamber depth (08:00: 2.91 ± 0.28 mm and 16:00: 2.92 ± 0.29 mm, P = 0.053) (Table 1). The diurnal changes in the amplitude of accommodation and anterior segment parameters during the fasting period are also listed in Table 1.

The ICCs recorded in the fasting period ranged from 0.924 to 0.996, and intraobserver reliability was excellent for all parameters (Table 1).

**Table 1.** Accomodation amplitude and anterior segment parameters of participants during fasting at 08:00 and 16:00 hours

| | 08:00 (n = 68) Mean±SD | 16:00 (n = 68) Mean±SD | Δ (n = 68) Mean±SD | P* 08:00 vs. 16:00 | ICC** (95% CI) |
|---|---|---|---|---|---|
| AA (diopter) | 7.39±1.40 | 7.37±1.40 | 0.02±0.55 | 0.783 | 0.924 (0.949-0.889) |
| K1 (diopter) | 42.81±1.51 | 42.85±1.50 | −0.04±0.12 | 0.016 | 0.996 (0.998-0.995) |
| K2 (diopter) | 43.77±1.66 | 43.79±1.67 | −0.02±0.15 | 0.337 | 0.996 (0.997-0.994) |
| Kmax(diopter) | 44.29±1.73 | 44.38±1.78 | −0.09±0.32 | 0.020 | 0.982 (0.988-0.973) |
| CCT (µm) | 535.60±30.43 | 535.25±30.66 | 0.35±7.36 | 0.694 | 0.971 (0.981-0.957) |
| CV ($mm^3$) | 59.72±3.85 | 59.60±3.98 | 0.11±0.99 | 0.344 | 0.968 (0.979-0.953) |
| ACV ($mm^3$) | 170.91±30.77 | 171.22±32.61 | −0.31±10.42 | 0.808 | 0.947 (0.964-0.921) |
| ACD (mm) | 2.91±0.28 | 2.92±0.29 | −0.01±0.04 | 0.053 | 0.988 (0.992-0.983) |

**Paired sample t-test. Bolded values represent significant, P < 0.05.*

***P < 0.001 for ICC (95%CI) values.*

*Δ, diurnal change (mathematical subtraction of 08:00 hour value from 16:00 hour value of parameters); AA, accomodation amplitude; ACD, anterior chamber depth; ACV, anterior chamber volume; CCT, central corneal thickness; CI, coefficient interval; CV, corneal volume; ICC, intraclass correlation coefficient; K1, K2, and Kmax, corneal refraction parameters; SD, standard deviation.*

## Discussion

A restricted number of studies have shed light on the diurnal impacts of Ramadan fasting on visual parameters and especially on structural parameters (4-9).

This study aimed to evaluate whether dehydration due to Ramadan fasting affects amplitude of accommodation, corneal refraction, central corneal thickness, corneal volume, anterior chamber volume, and anterior chamber depth parameters and their diurnal changes.

Factors such as dehydration and changes in sleep patterns that occur during the fast of Ramadan can affect the functional characteristics of the eye, such as the accommodation amplitude (16). Significant reductions in basic tear secretion and tear break-up time (TBUT) have been evaluated during Ramadan fasting (17). Furthermore, it has been found that reduction in TBUT can cause optical distortions, which contribute to the decay in image quality observed impartially and psychophysically (18).

In any case, investigations are few and inconclusive with respect to the direct effect of Ramadan fasting on visual aptitudes.

Under normal conditions, it has been shown that the amplitude of accommodation decreases with age, with more diurnal change in the younger age group compared to other age groups (19). Comparison of mean accommodation amplitude measurements obtained at 08:00 and 16:00 during fasting showed that the measurements taken at 16:00 were lower than those taken at 08:00. However, there was no significant difference in the diurnal change. Although the results show that fasting affected the accommodation amplitude measured subjectively with the minus lens technique, it did not significantly affect the diurnal change in the pre-presbiopic participants. In a study conducted by Yazdi et al. (16), a significant reduction in amplitude of accommodation was reported during Ramadan fasting compared to before; it returned to normal after Ramadan. Unlike the current study, that study did not evaluate the diurnal change in amplitude of accommodation during the fasting period.

Regarding diurnal fluctuations in corneal refraction, Kwitko et al. found that the corneal refraction values decreased toward the evening (20). In a study performed by Sarıcı et al. in which the Scheimpflug camera system was used and diurnal changes during fasting were evaluated, significant changes were found in the anterior segment parameters only in corneal refraction and in anterior chamber volume, while no significant changes were found in anterior chamber depth and other parameters (21). Similar to the current study, it was observed by Uyar et al. that there was an increase in the measurement of corneal refraction during fasting in the afternoon, but unlike the current results, this increase was not significant (22).

Many studies have reported that central corneal thickness was the thickest when the participant had awakened from sleep, decreased to average values approximately two hours after waking up, and exhibited significant thinning from morning hours to evening hours (9). In agreement with other studies in which the effect of fasting on anterior segment parameters was evaluated with the Scheimpflug camera system, the present results indicate that the central corneal thickness and corneal volume values decreased toward the end of the day, although the magnitude of the diurnal change was not significant (7, 23).

It has been reported that there is a deepening in the anterior chamber toward evening hours under normal conditions (14). In this study, although not significant, an increase was observed in the afternoon during the fasting period, consistent with the normal change.

One of the limitations of the present study was that a relatively low number of participants were included. Also, the absence of control measurements taken during the non-fasting period was a limitation.

In conclusion, despite the reported changes not being clinically impressive within the young and visually normal participants, they may have clinical impacts in larger samples, other age groups, and people with ocular diseases. It should be kept in mind that when eye examinations are conducted and evaluated during the fasting period, the accommodation amplitude of the eye decreases with age and that the change during the day may increase. In the literature, there are studies suggesting that the minus lens technique, which is evaluated subjectively, gives higher values for accommodation amplitude measurements than objective techniques (24). Further studies should be conducted with larger sample sizes to compare objective and subjective methods for measuring the amplitude of accommodation.

*__Ethical Approval:__ All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the Ethics Committee of Diyarbakır Gazi Yaşargil Training and Research Hospital (decision date: 28 June 2019, No. 307).*

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*Concept: A.A.D., M.K.*
*Literature Review: A.A.D.*
*Design : A.A.D., S.E.*
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*Writing manuscript: A.A.D.*
*Critical revision of manuscript: A.A.D., M.K., S.E.*

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