Valuation of Ocular Accommodation, Convergence and Fusional Vergence Changes during Ramadan

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ABSTRACT
Purpose: There are a few researches regarding the effects of Islamic fasting on visual system. The aim of this study was to investigate the effects of Ramadan fasting on the amplitude of accommodation (AA), near point of convergence (NPC), positive and negative fusional vergences (PFV and NFV, respectively) in visually healthy fasters.

Methods: AA, NPC, PFV and NFV at far (6m) and near (40cm) were measured in 30 male students. Nutritional habits in a week before each examination visit were assessed with the Food Frequency Questionnaire (FFQ).

Results: Mean age and fasting average experience were 23.9 and 10 years, respectively. AA and NPC showed significant changes (p<0.05) during Ramadan; but there was no significant difference before and after Ramadan in these parameters. NFV blur, break and recovery points at far significantly reduced in Ramadan than before (p=0.003, p=0.005, p=0.003, respectively) with insignificant compensation after Ramadan. Results showed that there was no significant correlation between changes in diet pattern and AA, NPC and distant NFV variations (p<0.05).

Conclusion: Some visual problems may be reported at far and near visual tasks during Ramadan; but most of the problems may be resolved after it. Some visual preparations may be needed for more effective visual activities during Ramadan; essentially for students with intensive visual tasks. Vision therapy may be suggested along with nutrient pattern improvement during Ramadan.

Introduction
Fasting during the month of Ramadan is an Islamic obligatory and millions of Muslims around the world refrain eating and drinking from sunrise to sunset according to this Islamic rule. Many investigations have been performed regarding the effect of fasting on human body as follows; the changes occur in body weight, (1) appetite, (2) renal functions in kidney transplant recipients, (3) blood pressure, (4) blood lipid levels, (5) and blood glucose. (6) Islamic fasting might have special effects on vision and ocular function of Muslims. Previous studies have shown that there is no association between Islamic fasting and progression of myopia. (7-10)

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Moreover, intraocular pressure changes due to fasting in healthy individuals have not been considerable. (11, 12)

Nocturnal sleep, daytime alertness and psychomotor performance are decreased in Ramadan; and this may lead to reduction of working hours during the month of Ramadan. (13) Decreasing nocturnal sleep may affect accommodative functions, on the other hand. (14) Nevertheless, the effect of insufficient nocturnal sleep accompanied with Ramadan fasting on amplitude of accommodation is a matter of research. Significant decrease in basic tear secretion and tear break up time has been observed during religious fasting. (15) Furthermore, it is found that tear break-up can create optical aberrations which contribute to the decline in image quality observed objectively and psychophysically. (16) Reduction of accommodative function and retinal image quality are two important factors in disrupting sensory fusion. (17) However, researches are few and not conclusive regarding the direct impact of Islamic fasting on visual skills.

In Ramadan, there is a considerable increase in amount of reading, especially to recite the Holy Quran. Increased need for visually demanding tasks and changes in food habits and metabolic conditions in this month call further investigations on possible visual changes during this month. Accordingly, this study designed to evaluate AA, NPC, PFV and NFV of Islamic fasters in Ramadan.

**Material and Methods**

In this cross sectional study AA, NPC, PFV and NFV of 30 male students from the student dormitory of Imam Ali (AS), affiliated to Tehran University of Medical Sciences, were measured during three days before Ramadan, middle three days and three days after this month. Participants were included in the study if they were fasting at least for 25 days in Ramadan. In addition, they were required to be less than 35 years old with minimum uncorrected visual acuity of 20/25 in each eye and without any ocular or medical pathology.

Participants took part in three optometric examinations, before, during and after Ramadan. Examination time before and after Ramadan was during breakfast to lunch and lunch to dinner times; while in Ramadan it was in between dawn and breakfast meals. Participants’ full ocular and systemic histories were recorded. Visual acuity was measured with Snellen acuity chart at 6 meters and dry retinoscopy was performed to ensure the absence of significant refractive errors. To determine participants’ inclusion or exclusion, heterophoria at 6 m and 40 cm and steroiacuity at 40 cm were measured with alternate cover test method, (18) and TNO plates,(19) respectively. Then, AA, NPC, PFV and NFV at far (6m) and near (40cm) were quantitatively measured randomly by an optometrist. All participants signed an informed consent in accordance with the tenets of the Declaration of Helsinki.

AA was monocularly measured with push up technique. The 6 point (20/30) optotype was held in front of each eye. As the participant should see the optotype clearly; so the target was moved to him slowly. If he reported that the optotype was unclear, the distance between the target and spectacle plane was measured. This distance was converted to dioptic value and was considered as the amplitude of accommodation. (20)

PFV and NFV blur, break and recovery points were measured at 40 cm and 6 m with a horizontal prism bar (21), using a vertical row of 20/30 letters as the target. (18)

NPC was evaluated by asking the participant if he reported the isolated 20/50 letter (accommodative target) was seen as single when the examiner held the target approximately 20 cm in front of his eyes. Then he was asked to say when the object appeared to be double. Also the examiner watched the participants’ eyes carefully. Any ocular deviation or misalignment during the NPC measurement showed the near point of convergence objectively. The distance from this point to forehead plane was recorded as the near point of convergence. (18, 21)

To be unaware of the results of previous visits, the study was blinded by recording the results from each visit in three separated record sheets. In addition, to consider nutritional status of participants over one week before each visit, the Food Frequency Questionnaire (FFQ) (22) was completed.

Results from this study were analyzed with SPSS 16 by repeated measures of ANOVA, paired t-test, Friedman nonparametric test and Spearman nonparametric correlation.

**Result**

Of 41 dormitory students examined, 30 ones had inclusion criteria for this study and were examined in 3 visits before, during and after the month of Ramadan. These participants, all male, with the mean age of 23.9±2.34 years (range: 21-30 years) had an average experience of fasting for 10.1±2.68 years (minimum 5and maximum 15 years).
Results of statistical analysis did not show any significant difference in PFV blur, break and recovery points at far and near and NFV blur, break and recovery points at near before, during and after Ramadan (Repeated measure ANOVA, \( p > 0.05 \)).

According to the results of paired t-test, AA of both right and left eyes were significantly reduced during Ramadan than before \(( p < 0.0001 \) ); but no significant difference was observed between their values before and after Ramadan \(( p = 0.184, \ p = 0.084 \), respectively); such that AA of right and left eyes reduced \( 1.62 \pm 2.11 \) D and \( 1.60 \pm 2.13 \) D respectively in comparison with before Ramadan; and increased \( 1.04 \pm 1.72 \) D both in right and left eyes after the month of Ramadan in comparison with the middle of this month \( \( p = 0.002 \)\).

NPC was increased significantly during Ramadan than before \(( \text{Paired } t\text{-test}, \ p = 0.006 \) ); but there was no significant difference between its values before and after this month \(( \text{Paired } t\text{-test}, \ p = 0.538 \) ); such that NPC was increased \( 0.86 \pm 1.54 \) cm during Ramadan than before; and reduced \( 0.86 \pm 1.54 \) cm after this month than midmonth. (See table 1 and figure 2)

![Figure 1](image1.png)

**Figure 1.** AA Values Before, During and After Ramadan. (The Error Bars Represent \( \pm \) Standard Error of Mean).

![Figure 2](image2.png)

**Figure 2.** NPC Values Before, During and After Ramadan. (The Error Bars Represent \( \pm \) Standard Error of Mean).

NFV blur, break and recovery points at far were considerably reduced during Ramadan than before \(( \text{Paired } t\text{-test}, \ p = 0.003, \ p = 0.005, \ p = 0.003, \) respectively); but no significant change occurred in its values after Ramadan than the middle of this month \(( \text{Paired } t\text{-test}, \ p = 0.611, \ p = 0.515, \ p = 0.865, \) respectively). (See table 1 and figure 3)

Diet analysis of foods consumed a week before visits using Friedman nonparametric test showed

| Table 1. Mean ± SD of AA, NPC and Distant NFV Before, During and After Ramadan 10.1±2.68 years (minimum 5 and maximum 15 years). |
|---|---|---|---|---|---|
| Variable | Before Ramadan | During Ramadan | After Ramadan | \( P_1 \) | \( P_2 \) | \( P_3 \) |
| Right Eye Amplitude of Accommodation | 13.94±2.67 | 12.33±2.50 | 13.37±2.20 | <0.0001 | 0.002 | 0.184 |
| Left Eye Amplitude of Accommodation | 13.93±2.68 | 12.33±2.50 | 13.33±2.20 | <0.0001 | 0.002 | 0.086 |
| Near Point of Convergence | 7.67±3.25 | 8.70±3.60 | 7.83±2.76 | 0.006 | 0.005 | 0.267 |
| Negative Fusional Vergence at far, Blur point | 11.24±4.35 | 8.57±2.23 | 8.36±2.72 | 0.003 | 0.611 | <0.0001 |
| Negative Fusional Vergence at far, Break point | 11.21±4.56 | 8.64±2.37 | 8.36±2.72 | 0.005 | 0.515 | <0.0001 |
| Negative Fusional Vergence at far, Recovery point | 8.86±4.23 | 6.36±2.31 | 6.29±2.70 | 0.003 | 0.865 | 0.001 |

*Comparison between before and during Ramadan
** Comparison between during and after Ramadan
*** Comparison between before and after Ramadan
that there were no significant changes in consuming amounts of carbohydrates (bread, rice, spaghetti, and candies), meats, legumes, stews, fruits, vegetables, nuts, dairy, and beverages in Ramadan than before and after it. On the other hand, consuming egg was reduced; and consumption of simple sugars such as table sugar, jelly, honey and date were significantly increased \( (p<0.05) \). Results using Spearman test showed that there was no significant correlation between changes in diet pattern and AA, NPC and distant NFV variations \( (p<0.05) \).

**Discussion**

In this study we found that significant increase in NPC along with significant reduction of AA occurred simultaneously during Ramadan. Right and left eyes AA reduced 1.62±2.11 D and 1.60±2.13 D during Ramadan than before. Despite the statistical significance of this reduction, a change of at least 1.50 D, according to some researchers’ viewpoint, is needed to be considered as a significant variation on repeated measurements of accommodative amplitude; smaller changes are accepted as expected variations. \( (23) \) On the other hand, mean AA of right and left eyes were 12.33±2.50 D during Ramadan. Considering the participants’ mean age which was 23.9 years, this value is more than the minimum expected AA, based on the Hofstetter formula. \( (24) \) Despite the significant reduction of monocular AA during Ramadan, its value was within the normal range in these young and visually normal participants. Another consideration is the fact that despite a significant increase in AA after Ramadan than the midmonth, its value showed reduction than before Ramadan. Although it was not statistically significant, the mean decreases were 0.57 D and 0.55 D in right and left eyes, respectively; but this may be significant in larger samples, different age groups or individuals with accommodative and convergence disorders. The mean NPC value was 8.70±3.60 cm in this month. Although NPC values of 5-7 cm is considered normal by some authors, \( (25-27) \) a range of 8-15 cm is considered normal in many researches, \( (28-31) \) however. As NPC values greater than 10 cm is a diagnostic criterion for convergence insufficiency, it seems that despite the statistically significant increase in NPC value during Ramadan than before, this is not clinically significant. But if larger samples, different age groups or patients with accommodative and binocular disorders are studied, it is possible to judge more confidently in this regard.

It seems that psychological factors and variations in biological time play a causative role in reducing AA and increasing NPC in this month. Different investigations on Ramadan and Islamic fasting have shown that the daytime fasting required during Ramadan lead changes to many aspects of the participants’ lifestyle, including sleep patterns and activity, in addition to complete absence of food and fluid intake. \( (32) \) Indeed the amounts of physical, mental and social activity performed in the daytime decrease in Ramadan. \( (32) \) During the fasting time, some behavioral disturbances, such as feeling tired and being unwilling to work have been observed, also. \( (33) \) On the other hand, subjective alertness and mood have reported to decrease during Ramadan intermittent fasting. \( (34) \) Therefore psychological factors such as feeling tiredness and being unwilling to work may cause subjects not to do their best during demanding visual tasks. In the study by Zerguini et al \( (35) \) on the impact of Ramadan on physical performance in professional soccer players, it was noted that the phase shift of food intake and disruption of sleep patterns affected actual and perceived physical performance. Meckel et al \( (36) \) concluded that Ramadan fasting may lead to a significant decrease in athletic performance capacities while this could not necessarily relate to changes in caloric intake and sleeping hours during the fast. Although these studies are not in the field of vision, but have related the athletes’ decrease in physical performance to disruption of biological time.

Moreover, nutritional pattern analysis showed no significant difference in most nutrient groups’ consumption over a week before each examination visit with each other; and significant differences were observed in protein and sugar taking in Ramadan compared to before Ramadan.
There was no significant correlation between AA and NPC variations with nutrients consumed during Ramadan, however.

Although no significant variations observed in PFV values at far and near and NFV values at near, but NFV blur, break and recovery points at far were significantly reduced during Ramadan than before (Paired t-test, p=0.003, p=0.005, p=0.003, respectively) and this reduction was not compensated after Ramadan (Paired t-test, p=0.611, p=0.515, p=0.865, respectively). Antona et al (37) studied the repeatability in the measurement of horizontal fusional vergences and found that NTV measurements showed better repeatability than PFV at both near and distance. Therefore the reduction of NTV that we observed during Ramadan was meaningful. However, NTV was not needed at far in this sample, as none of the participants had distance esophoria. Since NFV has a little role in maintaining fusion at distance, it seems that the mechanism to compensate its reduction in Ramadan occurs weakly. The third examination was in a week after Ramadan, and thus it is not clear whether amounts of blur, break and recovery points of NFV at far would equal with those before Ramadan; and if yes, how much time does this compensation take to occur after Ramadan.

**Conclusion**

Results showed that a considerable increase in NPC value and a significant decrease in AA and distant NFV were occurred during Ramadan than before; however the changes were compensated after Ramadan except for NFV at far. Significant variations in both distant and near PFV and near NFV were not observed in Ramadan. Although these changes were not clinically considerable in the young and visually normal participants of this study, but in other age groups, larger samples and individuals with nonstrabismic visual disorders, they might have clinical impacts. It is advised to prescribe proper accommodative and convergence trainings by optometrists to Islamic fasters during Ramadan to prevent these variations. More researches in this field are required.

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**References**