Impact of Ramadan fasting on intraocular pressure, visual acuity and refractive errors

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ABSTRACT

Introduction: Fasting evidently influences a variety of physiological parameters that can impact the ocular system. Among these modifications are alterations in insulin secretion, sympathetic activity, free fatty acids, lipid profile, melatonin, cortisol, electrolytes and catecholamines. In this study, we investigated the possible alterations in intraocular pressure (IOP), visual acuity and refractive errors during Ramadan fasting.

Methods: IOP, visual acuity and refractive errors of both eyes of volunteers were measured on the first and last days of Ramadan (once in the morning and evening). Body weight was measured so as to estimate the amount of dehydration. Data from the two examinations was analysed using one-way analysis of variance. A p-value of less than 0.05 was considered statistically significant.

Results: 58 healthy, fasting male volunteers with a mean age of 40.7 +/− 7.1 years participated in the study. Statistical analysis demonstrated no difference in IOP, visual acuity or refractive errors on the first and last days of Ramadan, or within a single day (from morning to evening).

Conclusion: Our results reveal that Islamic Ramadan fasting does not profoundly affect physiological IOP, refractive error or visual acuity values in healthy volunteers. However, more detailed investigations using animal models should be designed to evaluate whether fasting has a pivotal influence on pathological conditions.

Keywords: body weight, intraocular pressure, Ramadan fasting, refractive errors, visual acuity

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INTRODUCTION

Fasting is among the most prevalent activities in the world; many people observe fasting regardless of nationality or religion. Muslims refrain from eating or drinking during daylight hours in the ninth month of the Islamic calendar, the Ramadan festival, which can occur in any season.[1,2] The pattern, type and amount of food consumed during Ramadan evidently differ from that consumed during other months. The interaction among the lifestyle modifications involved in the intermittent fasting of Ramadan has raised concerns regarding the possibility of health problems or exacerbation of current disorders. Investigators all over the world are considering the effects of Ramadan fasting on the physiological and pathological conditions of individuals.[3]

As shown in several studies, fasting influences a variety of physiological parameters that can impact the ocular system, triggering a fall in insulin secretion and a rise in glucagon and sympathetic activity,[4] which can lead to free fatty acid release[5] and elevated norepinephrine and cortisol concentration.[4] With respect to the suggested role of these hormones in retinal hyperperfusion[6] and increased intraocular pressure (IOP),[7] one may anticipate a hypothetical distortion of ocular parameters during Ramadan. Fasting can affect lipid profile,[8] melatonin,[9] cortisol[10,11] and electrolytes,[3] which are also demonstrated to have a remarkable impact on ocular function. Weight loss and dehydration are among the physiological characteristics that undoubtedly affect fasting individuals; water deprivation in those who observe the fast has been functionally demonstrated to have a significant influence on the serum levels of sodium, chloride, bicarbonate, potassium, haematocrit, albumin, creatinine, urea and urinary osmolality.[3]

It is well known that serum electrolytes affect ocular blood flow and IOP. Sodium and bicarbonate modulating systems, renin-angiotensin system and carbonic anhydrase are among the pathways modified to control IOP and glaucoma.[12-14] Altogether, it seems that fasting modifies many physiological parameters that in turn affect the ocular system. Dadeya et al have reported a statistically significant decrease in IOP among fasting patients.[8] Inan et al have also found a decrease in IOP,[15] although not a significant one. There are also reports that assess the effects of fasting on visual

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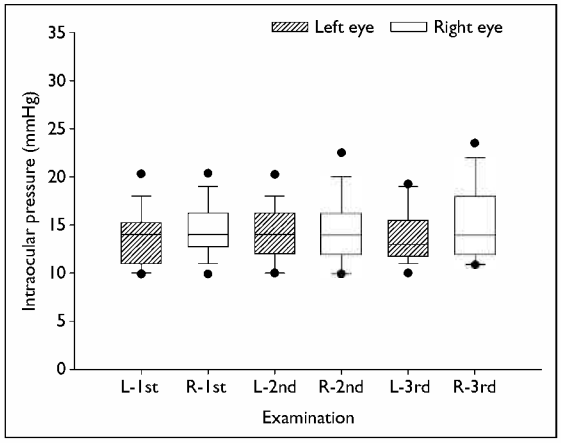

Fig. 1 Boxplot shows the effects of Ramadan fasting on intraocular pressure. The horizontal line represents the 95% confidence interval of mean.

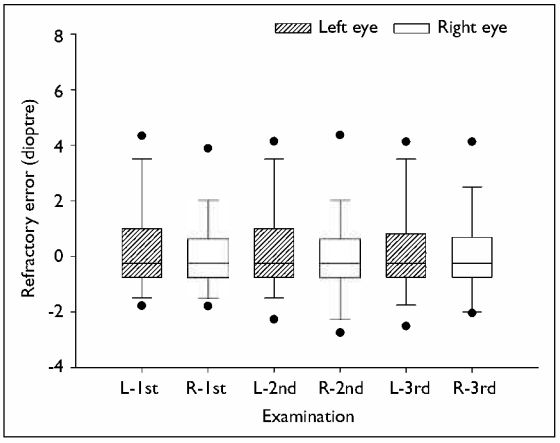

Fig. 2 Boxplot shows the effects of Ramadan fasting on refractive error. The horizontal line represents the 95% confidence interval of mean.

flicker vision,[16] retinal vein occlusion[17] and basal tear secretion.[18] Due to controversies in the limited studies previously conducted, as well as the importance of regional investigations of discrepancies in fasting period and nutritional patterns, this study was conducted with an aim to evaluate the possible changes in IOP, visual acuity and refractive errors during Ramadan.

METHODS

A total of 65 healthy, fasting male volunteers were enrolled in the study. Women were excluded, as fasting was not practised during their menstrual cycle. Patients with systemic diseases such as hypertension and diabetes mellitus, cardiovascular diseases, ocular hypertension, glaucoma and a family history of glaucoma were also excluded, as were seven volunteers who did not complete the study.

IOP, visual acuity and refractive errors of both eyes of the volunteers were measured by an ophthalmologist using an applanation tonometer, logMAR and automated refractometer (KR 8800, Topcon Corp, Tokyo, Japan), respectively. The average of at least two separate measurements was used for statistical evaluation; ocular parameters were evaluated on the first and last days of Ramadan. Data for the first day was obtained at two different points in time, in the morning and afternoon, so as to include possible diurnal fluctuations. The volunteers' body weight was also measured to determine the amount of estimated dehydration. The study complied with the Declaration of Helsinki and was approved by the institutional ethics committee of Bushehr University of Medical Sciences. All patients provided written informed consent.

Data was presented as mean ± standard deviation, with ranges provided, where appropriate. Data resulting from two examinations was analysed using the analysis of variance. A p-value < 0.05 was considered statistically significant. The Statistical Package for the Social Sciences version 11.5.0 (SPSS Inc, Chicago, IL, USA) was used for statistical analysis.

RESULTS

A total of 65 healthy, fasting male volunteers age 40.7 ± 7.1 years were involved in the study. The acquired data for IOP in volunteers was 13.828 ± 0.473 mmHg, 14.414 ± 0.432 mmHg and 13.966 ± 0.418 mmHg for the left eye, and 14.517 ± 0.476 mmHg, 14.86 ± 0.590 mmHg and 15.345 ± 0.617 mmHg for the right eye, on the first day morning, first day afternoon and last day of Ramadan, respectively. Statistical analysis demonstrated no difference in the volunteers' IOP on the first and last days of Ramadan, as well as within a single day (Fig. 1).

The refractive error was 0.310 ± 0.238 dioptre, 0.336 ± 0.249 dioptre and 0.302 ± 0.250 dioptre for the left eye, and 0.168 ± 0.234 dioptre, 0.129 ± 0.248 dioptre and 0.198 ± 0.242 dioptre for the right eye on the first, second and third examination, respectively. Statistical analysis of the data indicated no significant changes during Ramadan and no diurnal fluctuations (Fig. 2). The visual acuity parameters did not change within a single day during Ramadan and during the whole month. The visual acuity values for the volunteers were 0.0483 ± 0.0173, 0.0448 ± 0.0172 and 0.0517 ± 0.0173 for the left eye, and 0.0345 ± 0.0087, 0.0310 ± 0.0078 and 0.0310 ± 0.0078 for the right eye on the first, second and third examination, respectively (Fig. 3).

The average weight of the volunteers was 78.609 ± 1.591 kg, 77.583 ± 1.562 kg and 77.241 ± 1.669 kg on the first day morning, first day afternoon and last day of Ramadan, respectively. Although a slight reduction in the weight of volunteers was observed, the alteration was not statistically significant (Table I).

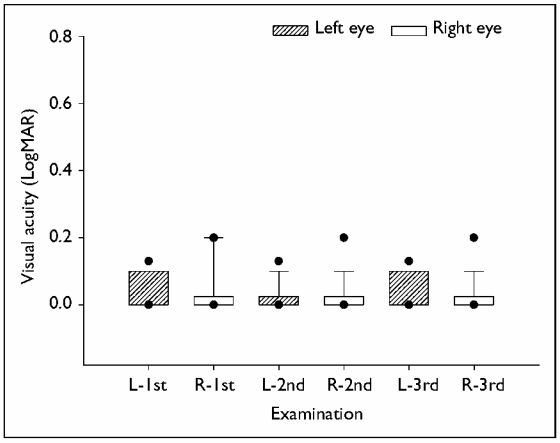

Fig. 3 Boxplot shows the effects of Ramadan fasting on visual acuity. The horizontal line represents the 95% confidence interval of mean.

Table 1. Summarised data of ocular parameters and body mass evaluated in the study.

Type of examination	Mean ± SD	95% CI	p-value
Weight			0.822
First	78.61 ± 12.12	75.42, 81.79	
Second	77.58 ± 11.90	74.45, 80.71	
Third	77.24 ± 12.71	73.90, 80.58	
Left eye-IOP (mmHg)			0.619
First	13.83 ± 3.60	12.88, 14.78	
Second	14.41 ± 3.29	13.55, 15.28	
Third	13.97 ± 3.18	13.13, 14.80	
Right eye-IOP (mmHg)			0.582
First	14.52 ± 3.63	13.56, 15.47	
Second	14.86 ± 4.49	13.68, 16.04	
Third	15.34 ± 4.70	14.11, 16.58	
Left eye-refractory error (dioptre)			0.995
First	0.31 ± 1.81	−0.17, 0.79	
Second	0.34 ± 1.90	−0.16, 0.83	
Third	0.30 ± 1.90	−0.20, 0.80	
Right eye-refractory error (dioptre)			0.98
First	0.17 ± 1.78	−0.30, 0.64	
Second	0.13 ± 1.89	−0.37, 0.63	
Third	0.20 ± 1.84	−0.29, 0.68	
Left eye-visual acuity (logMAR)			0.961
First	0.05 ± 0.13	0.01, 0.08	
Second	0.04 ± 0.13	0.01, 0.08	
Third	0.05 ± 0.13	0.02, 0.09	
Right eye-visual acuity (logMAR)			0.942
First	0.03 ± 0.07	0.02, 0.05	
Second	0.03 ± 0.06	0.02, 0.05	
Third	0.03 ± 0.06	0.02, 0.05	

SD: standard deviation; IOP: intraocular pressure

DISCUSSION

Gross differences in the amount, type and pattern of nutrition during fasting festivals may raise concerns regarding the possible harmful influences of fasting; scientists all over the world are considering the effects of fasting on physiological or pathological conditions. Nearly all nations and religions have some kind of fasting festival, although the length of fasting and type of food consumed differ greatly among countries; some regions refrain from eating and drinking for a long period of time, while others observe a short, intermittent fast.[2,3,5] These divergences in fasting patterns require several regional studies with large sample sizes so as to avoid any possible false conclusions and extrapolation of data to other nations. The effects of Ramadan on different organs have been extensively studied and reviewed; however, its effect on ocular vision has not been fully acknowledged and thus demands more attention.

A slight diminution of serum glucose a few hours after fasting, followed by a fall in insulin secretion and a rise in glucagon and sympathetic activity, has been noted in fasting individuals.[4] However, in most studies, HbA1c, fructosamine, insulin and C-peptide have shown no noticeable alteration.[19] In experimental fasting, an augmentation of indirect bilirubin occurs, which may, to some extent, correlate with carbohydrate metabolism.[5] A decrement in circulating insulin and an increment in catecholamine and glucagon levels result in the augmentation of free fatty acids as a consequence of lipolysis;[5] free fatty acids have also been demonstrated to enhance ocular blood flow and may play a role in the development of retinal hyperperfusion.[6] Elevated levels of norepinephrine and cortisol due to hyperactivation of sympathetic pathways are also associated with the elevation of IOP.[7]

Alteration of blood lipid profile likely depends on the quality and amount of food consumed. Diminished low density lipoprotein as well as a marked elevation of high density lipoprotein and apolipoprotein A-1, with falls in apolipoprotein B, have also been described.[5] Depletion of lipid stores during fasting may diminish prostaglandin secretion, thereby resulting in a decrease in IOP.[8] The onset and rhythm of cortisol secretion have been found to shift during Ramadan;[10,11] ocular hypertension has been demonstrably associated with augmented levels of plasma free cortisol.[20-22] It has also been shown that the administration of hydrocortisone for five weeks did not significantly elevate IOP in dogs.[23] The nocturnal peak of melatonin has also been found to diminish, showing a delay in comparison to normal days.[9] Melatonin has a proposed role in the diurnal rhythm of IOP;[24] melatonin receptor and secretion interventions have also been suggested for the management of glaucoma,[25] while it was reported that melatonin did not significantly increase IOP in rabbits.[26]

The direct effects of fasting on visual parameters such as IOP,[8,15] visual flicker vision,[16] retinal vein occlusion[17] and basal tear secretion[18] were considered in this study. We observed no remarkable reduction in the

body weight of volunteers involved in the study, contrary to the study conducted by Dadeya et al, which reported a decrease in body weight.[8] However, differences in geographical area and the larger sample size in our study may explain this discrepancy to some extent. There was no noticeable change in the IOP of volunteers during the whole month or within a single day. In contrast to our study, Dadeya et al, who evaluated IOP in 38 healthy male patients, reported a statistically significant decrease in IOP among fasting participants,[8] whereas Inan et al found a diminished but not significant decrement in IOP in their study.[15] Kayikçioglu and Güler measured IOP in 38 male patients during the Islamic Ramadan in Turkey and reported a slight decrement in body mass but no significant difference between IOP during fasting and non-fasting periods,[27] which concur with the results of our study. It appears that although fasting may increase IOP due to elevated free fatty acids, cortisol and sympathetic hyperactivity, or due to a decrease in IOP resulting from dehydration and prostaglandin depletion, the final outcome indicates no evident change in IOP. The refractive error and visual acuity values of volunteers in our study were also not fundamentally altered during Ramadan, and showed no noteworthy diurnal variations. Although Alghadyan reported a retinal vein occlusion during Ramadan,[17] the occlusion may not critically impair visual acuity, refractive errors or IOP.

To conclude, our results reveal that Islamic Ramadan fasting does not profoundly affect physiological IOP, refractive error or visual acuity values in healthy volunteers. However, more in-depth experimental investigations using animal models should be designed to evaluate whether fasting has a pivotal influence on pathological conditions.

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