The effects of Ramadan fasting on heart rate variability in healthy individuals: A prospective study

Mehmet Cansel, Hakan Taşolar[1], Jülide Yağmur, Necip Ermiş, Nusret Açıkgöz, Ferhat Eyyüpkoca, Hasan Pekdemir, Ramazan Özdemir

Department of Cardiology, Faculty of Medicine, İnönü University; Malatya-*Turkey*
[1]Department of Cardiology, Adıyaman University, Training and Research Hospital; Adıyaman-*Turkey*

ABSTRACT

Objective: Ramadan fasting is one of the five fundamental rituals of Islam. Heart rate variability (HRV) is an independent predictor of increased mortality of patients with myocardial infarction and congestive heart failure. Although many patients in this region fast once a year, the effects of fasting on the HRV, which has a prognostic significance for patients with myocardial infarction and congestive heart failure, are not known. Therefore, the study on the effects of one month fast of HRV in healthy volunteers seems to be reasonable to address.

Methods: Our study is a prospective cohort study that includes a total of 40 healthy volunteers with sinus rhythm between 19 and 40 years of age (16 female and 24 male). HRV was determined twice by ambulatory 24-hour Holter recordings at fasting in the middle of Ramadan and first week after Ramadan month. Mean values of continuous variables were compared by using the Student t-test or Mann-Whitney U test. Paired t-test or Wilcoxon test were used for comparison of variables between groups.

Results: When two groups compared, statistically significant differences were found in terms of RR (p=0.049), SDNNI (p=0.010), rMSSD (p=0.009), pNN50 (p=0.015), T power (p=0.009), LF (p=0.008), Lfnu (p=0.002), HF (p=0.022) and Hfnu (p=0.013) values.

Conclusion: In our study, HRV parameters were found to be increased in Ramadan month, so we think that Ramadan fasting enhances the activity of the parasympathetic system. *(Anadolu Kardiyol Derg 2014; 14: 413-6)*

Key words: Ramadan fasting, heart rate variability, autonomic nervous system

Introduction

Fasting is one of the five fundamental rituals of Islam. Fasting during Ramadan is a radical change in lifestyle for the period of a lunar month. Aproximately one billion Muslims fast during month of Ramadan in the world (1). Time of observance differs each year because it follows lunar calendar. Fasting period from dawn to sunset varies with geographical site and season. In summer months, the fasting can last up to 18 hours or more.

Heart rate variability (HRV) is a non-invasive method used to assess the effects autonomic nervous system (ANS) (2). HRV was also an independent predictor of increased mortality of patients with myocardial infarction and congestive heart failure (3, 4). Autonomic changes have been found to be associated with ischemia in patients with coronary artery disease (5). Low parasympathetic activity was found to be a marker for poor prognosis in non ST-elevation acute coronary syndrome patients (6). Several studies of HRV have led to significant prognostic information in chronic heart failure of both ischemic and non-ischemic etiology. Most of the studies have found that especially low standart deviations of all analyzed RR intervals (SDNN) predicts mortality in heart failure patients (7-9).

Although a large number of Muslim population exists all over the world, to our knowledge, there is a lack of data on the effect of Ramadan fasting on HRV parameters. Many patients in this region fast once a year, however the effects of fasting on the HRV, which has a prognostic significance of patients with heart failure and coronary artery disease, are not known. Therefore, the study on the effects of one month fast of HRV in healthy volunteers seems to be reasonable to address to clarify this issue.

Methods

Study design

This study was designed as a prospective cohort study which was performed in the Cardiology Department of İnönü University Turgut Özal Medical Center between August and September 2010. This study was approved by institutional Ethics Committee for human subjects. Informed consent was obtained from each study subject prior to participation in study.

Address for Correspondence: Dr. Hakan Taşolar, Adıyaman Üniversitesi Eğitim ve Araştırma Hastanesi, Kardiyoloji Kliniği, Adıyaman-*Türkiye* Phone: +90 416 216 10 15-1387 Fax: +90 416 214 25 25 E-mail: hakantasolar@gmail.com
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Study population

A total of 40 healthy volunteers betweeen 19 and 40 years (mean age 29.3±5.9) with 16 women (mean age 27.6±6.9) and 24 men (mean age 30.3±5.2) were included in this study. Exclusion criteria were; smoking, diabetes mellitus, hypertension, hyperlipidemia, hypothyroidism, hyperthyroidism, anemia, usage of anti-arrhythmic drugs, chronic obstructive lung disease, kidney failure, intracranial space-occupying lesions, congenital heart disease, valvular heart disease, coronary artery disease and having any infectious disease.

Study protocol

Ramadan elapsed between August 11 and September 10. Because our study was conducted in this months, daytime was longer than the night at this months, so fasting time was in equipoise to approximately 17 hours. Body weight and height were measured before and after Ramadan month, and body mass index (BMI) was calculated as weight in kilograms divided by the square of height in metres (kg/m^2). HRV was determined twice by ambulatory 24-hour Holter recordings, at first during in the middle of the fasting month of Ramadan, in between the 13th and 17th days, and secondly first week after Ramadan month. Records were compared to each other. Six-channel, ambulatory electrocardiographic recordings (DMS 300-7 HolterReader; DSM, Stateline, NV, USA) were obtained for 24 hours in all patients and control subjects. Before automatic analysis of tapes with Holter program (CardioScan 12.0 DM software, DSM), all electrocardiographic recordings were visually reviewed to delete artifacts. All data were reviewed by 1 analyst and edited. HRV was calculated using only normal-to-normal intervals. There had to be ±23 hours of analyzable data for the 24-hour recording to be accepted for study. Five time-domain measures were examined: standart deviations (SD) of all analyzed RR intervals, mean±SDs of all RR intervals for 5-minute segments of the analysis (SDNNI), square root of the mean of the sum of the squares of differences between adjacent RR intervals (rMSSD),and percent differences between adjacent RR intervals ±50 ms for the entire analysis (pNN50). SDNN can be influenced by parasympathetic and sympathetic stimulation compared with rMSSD and pNN50, which are mostly related to vagal tone. Frequency domain HRV indices: the Fast Fourier Transform method was used for the spectral measurements. Heart rate spectrum between 0.003 and 0.40 Hz was defined as total power (ms^2), combining the sum of all of the frequencies, is a global measure of ANS activity. This energy was divided into two components: low frequency (LF: 0.04-0.15 Hz) and high frequency (HF: 0.16-0.40 Hz). LF are affected by both vagal and sympathetic activity, whereas HF are affected by vagal tone. The low frequency/high frequency (LF/HF) ratio of heart rate variability power is used as a measure of cardiac sympathovagal balance in this study.

Statistical analysis

Statistical analysis were carried out using the SPSS statistical package, version 17.0 (SPSS Inc, Chicago, IL, USA) for Windows. Continuous variables were expressed as means±SD and categorical variables were expressed as numbers and percentages.

Table 1. The characteristics of the study population

Parameters	*Study population (n=40)
Age, years	29.3±5.9
Gender, male, %	24 (60%)
Weight, kg	61.8±7.5
Height, cm	165.3±8.4
BMI, kg/m^2	22.6±1.8

Values in mean±standard error. *Student's t-test, chi-square test
BMI - body mass index

Characteristics of distribution were tested with Kolmogorov-Smirnov test. Mean values of continuous variables were compared between groups using the Student t test or Mann-Whitney U test, according to whether normally distributed or not. Paired t-test or Wilcoxon test were used for comparison of variables between groups, according to whether normally distributed or not. A p value <0.05 was considered to be statistically significant.

Results

The characteristics of the study population are presented in Table 1. Subjects did not differ significantly in terms of weight (p=0.281) and BMI (p=0.257) during and after Ramadan.

HRV parameters of study population during and after Ramadan are presented in Table 2. Individuals did not differ with respect to heart rate (p=0.065), and SDNN (p=0.166) during and after Ramadan month. RR (p=0.049), SDNNI (p=0.010), rMMSSD (p=0.009) and pNN50 (p=0.015) indices significantly increased in Ramadan month. T power (p=0.009), LF (p=0.008), LFnu (p=0.002), HF (p=0.022), HFnu (p=0.013) indices also significantly increased in Ramadan month compared to after Ramadan, but LF/HF ratio (p=0.495) did not increase.

Discussion

Main finding of our study was that HRV parameters including SDNNI, rMSSD, pNN50, T power, LF, LFnu, HF and HFnu were significantly increased in the fasting month of Ramadan.

HRV is related to lifestyle in adults. Regular physical exercise, smoking, diet and disturbed sleeping patterns have significant effects on HRV in adults (10-13). Decreased HRV is associated with risk for cardiac events in adults (4) and a predictor of imminent hypertension (14). Even though death and acute coronary syndrome were shown not to be associated with Ramadan (15), HRV which can predict cardiac events in this population was evaluated in our study.

ANS and endocrine system play crucial roles in the signaling of the hunger and the satiety. Sympathetic (SNS) and parasympathetic nervous system (PNS) support the distinct and opposite functions in the alertness and physiology. In humans, within the relation to a hunger-satiety shift, changes of the SNS and PNS activity can occur before nutritional hormone levels are secreted, as demonstrated by the instant changes in the states of alertness (16-18), muscle sympathetic nerve activity (19), and cardiac output

Table 2. Heart rate variability parameters of study population during and after Ramadan

	During Ramadan	After Ramadan	*P* value*
Weight, kg	61.8±7.5	62.3±7.1	0.281
BMI, kg/m^2	22.6±1.8	22.8±1.8	0.257
Heart rate, beat/min	78.0±7.3	80.1±7.6	0.065
RR, msec	779.7±87.7	746.9±89.4	0.049
SDNN, msec	147.3±31.2	139.2±30.3	0.166
SDNNI, msec	65.8±12.1	60.6±12.7	0.010
rMSSD, msec	36.3±10.8	31.1±7.9	0.009
pNN50, %	13.9±8.2	10.0±5.7	0.015
Tpower	4517.5±1499.5	3865.5±1539.8	0.009
LF	1030.5±235.8	918.2±272.2	0.008
LFnu	24.1±5.7	21.1±5.6	0.002
HF	364.4±242.8	265.3±123.3	0.022
HFnu	8.0±4.3	6.4±3.0	0.013
LF/HF	3.7±1.8	3.9±1.8	0.495

Values in mean±standard error, *Paired t test or Wilcoxon test used for comparison. BMI - body mass index; HF - high frequency power; LF - low frequency power; nu - normalized units; pNN50-percentage of differences between adjacent normal RR intervals exceeding 50 ms, rMSSD - the square root of the mean of squared differences between adjacent normal RR intervals; SDNN - SD of normal RR intervals; SDNNI - mean of the SD of all RR intervals for all five minute segments

(20), which may be part of cephalic phase responses (21) after food intake. An inverse relationship of SNS activity and body fat, which suggests a role of β-adrenergic receptors in peripheral and central control of eating, emphasizes the importance of the SNS in food intake (22). Both short- and long term autonomic alterations occur towards a high sympathetic tone after a meal based on increases of HRV (23). Ramadan is less a formal fast and more a phase shift in food intake with a change in sleep cycles to accommodate the change in the timing of food intake. We therefore evaluated HRV parameters to assess the effects of changes of Ramadan fasting on SNS and PNS in our study.

During the Ramadan fast, Muslims eat two meals a day, one before dawn (Sahour meal) and the other shortly after sunset (İftar meal). This change of meal schedule is accompanied with changes in sleeping habits (1). Additionally, during the month of Ramadan, Muslims usually consume very high caloric food, and they sleep less in the night compared with other month because of Sahour (24). While the small changes in nutritional intake are unlikely to have any major impact on performance, it is possible that the phase shift in food and fluid intake, and change in sleep patterns could affect physical performance (25). Furthermore, it is shown in previous studies that if subjects maintain hydration and training, there seems at most a very small decrease in muscle contractile force during Ramadan (26). Even though bradycardia and hypotension may also occur during prolonged fasting (27), heart rate and blood pressure remain normal during first few days of fasting. Changes in electrocardiogram, including decreased altitude of QRS complex and T-wave and right axis deviation seen in prolonged fasting, are not seen in short fasts (28). We designed our study to much better observe the effect of fasting on HRV parameters during the summer months in which Ramadan fasting has relatively longer period.

SDNN and SDNNI are indicative of the whole HRV. RMSSD and pNN50 evaluate beat-to-beat fluctuations, and are considered good estimators of parasympathetic modulation of heart rate (29, 30). HRV was increased in healthy individuals with Ramadan fasting, as evidenced by increased SDNNI, pNN50 and RMSSD parameters evaluated from the entire recording. Support provided by marriage, religiosity or faith, and other forms of social connection have been associated with activation of the PNS and have decreased the risk of future cardiovascular events (31, 32). Vagal activity is the major contributor to the HF component. The HF component of spectral analysis is a marker of efferent vagal activity to the heart (33). Disagreement exists in respect to the LF component. Some studies suggest that LF, when expressed in normalized units, is a quantitative marker of sympathetic modulations; other studies view LF as reflecting both sympathetic activity and vagal activity (34, 35). Consequently, the LF/HF ratio is considered by some investigators to mirror sympathovagal balance or to reflect the sympathetic modulations (36). In our study, Tpower, LF, LFnu, HF and HFnu measurements were also found to be statistically higher in month of Ramadan fasting than in non-fasting days in healthy individuals. Since we performed this study in a summer Ramadan month which has a long duration of fasting period, it therefore result in the increased influence of parasympathetic activity on HRV parameters.

Study limitations

We couldn't follow up the patients prospectively for future major advers cardiac events is the most important limitation of our study. The lack of recording before fast and circadian variations which were not studied are the other limitations. Because our study was performed in the Ramadan month in summer months which have especially longer fasting periods, the effects of shorter Ramadan fasting are unknown. So new large scale studies are needed to clarify this issue.

Conclusion

HRV parameters were found to be increased in Ramadan month in our study. Although further long-term prospective studies are needed, our findings provide data regarding enhanced the activity of the parasympathetic system in healthy individuals. We hope that our results will lead to further studies about the HRV parameters, which has a prognostic significance of patients with heart failure and coronary artery disease.

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