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The effects of intermittent fasting on nighttime blood pressure levels

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Abstract

Hypertension, a preventable disease with a high prevalence, is frequently seen in obese patients with cardiovascular risk factors. Our study aimed to investigate the effect of an intermittent fasting regimen on nighttime blood pressure levels. Patients who applied to Karabuk University Faculty of Medicine Training and Research Hospital Cardiology and Family Medicine Polyclinic between January and March 2021 and were followed up for 24 hours on an outpatient basis were included in this self-controlled interventional study. Patients underwent a second 24-hour Holter blood pressure follow-up after one month of diet, and the results were compared. The study was conducted with 30 subjects who adhered to a one-month intermittent fasting regimen. 63.3% of the patients were male, and the mean age was 54.60 ± 9.71 years. One month later, 13 patients whose nighttime blood pressure improved were assigned to Group 1 and 17 patients to Group 2. There was no important variance between the groups in terms of gender, age, height, waist circumference and BMI (p=0.609, p=0.105 and p=0.087, in order of). Mean VA and BSA were considerably lower in Group 2 (p=0.027 and p=0.045, in order of). HT duration was longer in Group 1 (p=0.001). There was no important variance between the groups in terms of smoking, alcohol use, average daily sleep time, salt intake awareness and exercise habits. The rate of snacking habits in Group 2 was statistically considerably higher (p=0.033). Intermittent fasting may be beneficial in preventing nocturnal hypertension.

Keywords: hypertension, intermittent fasting, nighttime blood pressure, humans

1. Introduction

Hypertension (HT), characterized by increased intra-arterial blood pressure and caused by acquired, metabolic and genetic factors, is a condition with high mortality and morbidity, accounting for at least 45% of heart disease-related deaths and 51% of coronary heart disease-related deaths (1). Increasing risk factors such as population aging worldwide, unhealthy and sedentary lifestyles, and unbalanced diets increase the prevalence of HT (2). The incidence of HT is 25–30% in developed countries, compared with 30–35% in our country (3). While the rate of HT control with treatment is 25% in developed countries, it is only 10% in developing countries (4). Treatment of high blood pressure, regular blood pressure measurements, control of other diseases accompanying HT, a healthy and balanced diet, and stress reduction are important for good management of HT (5). The parasympathetic system is activated by nocturnal circadian rhythm, and systolic blood pressure is expected to decline by ≥10% during night rest in healthy individuals. In normotensive and hypertensive individuals, the nighttime average blood pressure decreases by ≥10% of the daytime average blood pressure, which is called the dipper pattern. On the other hand, the non-dipper pattern refers to a blood pressure, which is characterized by a nighttime dip, which is <10% lower than the daytime average blood pressure.

Intermittent fasting, i.e., periods of voluntary abstention from eating and drinking, has been practiced by people for health and religious reasons for thousands of years (6). Intermittent fasting is a dietary intervention similar to calorie restriction. It focuses on the timing of meals. It has been established that intermittent fasting regulates circadian rhythm by reducing oxidative stress and reduces cardiovascular risk and that good glucose control is achieved in individuals who are on an intermittent fasting regimen, and calorie restriction improves insulin sensitivity and blood pressure (6, 7).

In this context, our study aimed to explore the effect of prolonged nighttime fasting (the intermittent fasting regimen) on nighttime blood pressure levels in patients with high nighttime blood pressure.

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2. Materials and Methods

This self-controlled interventional study included patients who presented to the Cardiology and Family Medicine outpatient clinics in Karabuk University Faculty of Medicine Training and Research Hospital between January and March 2021 and underwent 24-hour ambulatory blood pressure monitoring within the indications. Individuals diagnosed with DM, working in shifts, pregnant, rejecting the second 24-hour Holter monitoring, and with nighttime systolic and diastolic blood pressure levels of <120/70 mmHg were excluded. A 24-hour blood pressure monitoring record was taken at admission from the patients who met the study criteria and agreed to participate in the study. Patients with a nighttime systolic blood pressure of ≥120 mm Hg and/or a nighttime diastolic blood pressure ≥70 mm Hg were considered to have nocturnal hypertension. Before the study, medical history was taken from the patients, and they were asked whether they had concomitant hypertension (HT), hyperlipidemia (HPL), coronary artery disease (CAD), cerebrovascular disease (CVD), psychiatric disorders, previous stent insertion, smoking and drinking habits. Height and body weight (BW) were measured. Body mass index (BMI) was calculated by the formula: body weight/height squared (kg/m^2), and body surface area (BSA) was calculated by the DuBois formula [$0.007184\times(W^{0.425}\times H^{0.725})$].

These patients were instructed not to eat solid foods after 18.00 for one month and not to smoke, and not to drink tea or coffee for 3 hours before bedtime. One month later, patients were asked whether they adhered to their diet, and a second 24-hour Holter monitoring of blood pressure was administered. Those with a nighttime systolic-diastolic blood pressure of≤120-70 mmHg after the intermittent fasting regimen were named “Group 1” (the group with improvement), and those without such decrease were named “Group 2” (the group without improvement).

The study data were analyzed using SPSS 22 software package. According to the results of the data analysis, pairwise comparisons were performed using the t-test for the normally distributed variables and the Mann-Whitney U test for the non-normally distributed variables. Categorical data were compared using the Chi-square analysis. The statistical significance level was set at $p<0.05$ for all analyses.

The study was approved by the Non-Interventional Clinical Researches Ethics Committee of Karabük University (Decision No: 2021/14 January 2021).

3. Results

Among a total of 129 patients who presented to the outpatient clinics during the study period and wore a Holter monitor, 24 were excluded due to being diagnosed with DM, 2 due to working in shifts, and 1 due to pregnancy. 33 patients refused the second 24-hour Holter monitorization despite the indication, and 39 patients had nighttime systolic and diastolic blood pressure levels of <120/70 mm Hg. The study was conducted on 30 individuals who adhered to a one-month intermittent fasting regimen and met the study criteria. Of the study patients, 36.7% were women, and 63.3% were men; the mean age was 54.60 ± 9.71 years (56.64±8.77 years in women, 53.42±10.25 years in men). After one month, 13 patients with improved nighttime blood pressure levels were assigned to Group 1 and 17 patients without any change to Group 2. There was no variance in total systolic, daytime systolic and daytime diastolic blood pressure levels between the two groups (p=0.176, p=0.307, and p=0.083, in order of) (Table 1).

Table 1. Comparison of changes in baseline and post-fasting blood pressure parameters between the groups

Mean Blood Pressure Variances	Group 1(n=13) Mean±SD	Group 2 (n=17) Mean±SD	*p*
Total Systolic	-5.23±10.21	-.53±8.33	0.176
Total Diastolic	-4.54±7.21	0.47±4.90	**0.031**
Daytime systolic	-4.92±11.03	-1.06±9.32	0.307
Daytime diastolic	-4.00±7.57	0.24±5.36	0.083
Nighttime diastolic	-14.15±9.44	-1.71±8.63	**0.001**
Nighttime Diastolic	-14.92±6.81	0.76±5.13	**0.0001**

The rate of men was 42.1% in Group 1, and 57.9% in Group 2, and the rate of women was 45.5% in Group 1 and 54.5% in Group 2. There was no important gender variance between the groups (p=1). The mean age was 56.00 ± 9.96 years in Group 1 and 53.53 ± 9.68 years in Group 2, and the variance was statistically unimportant (p=0.499).

The anthropometric measurements at the beginning of the study revealed no important variance in height, waist circumference, and BMI between the two groups (p=0.609, p=0.105, and p=0.087, in order of), while BW and BSA were considerably different between the groups (p=0.027 and p=0.045, in order of). The mean BW and BSA were considerably lower in Group 2 than in Group 1 (Table 2).

Table 2. Comparison of baseline anthropometric measurements between the groups

Anthropometric Measurements	Group 1 (n=13)	Group 2 (n=17)	Total (n=30)	*p**
Height (cm)	168.15 ±11.33	166.29 ±8.40	167.10 ±9.64	0.609
Waist Circumference (cm)	101.31 ±9.49	95.18 ±10.23	97.83 ±10.23	0.105
BMI (kg/m^2)	29.81 ±4.17	26.99 ±4.39	28.21 ±4.46	0.087
BW (kg)	84.23 ±14.14	74.12 ±9.60	78.50 ±12.63	**0.027**
BSA	1.98 ±0.21	1.85 ±0.13	1.90 ±0.18	**0.045**

*T-Test

According to the findings, 16.7% of the study group patients group had CAD, 13.3% had HPL, 6.7% had a stent,

3.3% had a history of CVE, and 13.3% had a psychiatric disorder. There was no important variance in the presence of HT, presence of HPL, presence of CAD, and presence of CVE between the groups (p=0.443, p=0.113, p=1, p=1). The duration of hypertension was considerably different between the groups (p=0.001). The duration of HT (11.23 ± 4.19 years) was longer in Group 1 than in Group 2 (5.12 ± 3.16 years). The mean time to diagnosis of hypertension was considerably longer in patients without improvement in nighttime blood pressure. Of the patients, 23.3% had smoking, and 3.3% had drinking habits. There was no important variance in smoking and alcohol use between the groups (p=0.613, p=0.443).

The mean sleep duration per day was 7.62 ± 1.21 hours in Group 1 and 7.65 ± 0.97 hours in Group 2, with no important variance between the groups (p=0.867). Concerning the eating and lifestyle habits of the participants, 56.7% had snacking habits, 36.7% had salt awareness, and 43.3% had exercising habits. There was no important variance in salt awareness and exercising habits between the groups (p=0.165 and p=0.454, respectively). The rate of snacking habits was statistically considerably higher in Group 2 than in Group 1 (p=0.033) (Table 3).

Table 3. Comparison of eating and lifestyle habits between the groups

		Group 1		Group 2		Total		p
		n	%	n	%	n	%	
Snacking Habits	No	9	69.2	4	30.8	13	100.0	**0.033**
	Yes	4	23.5	13	76.5	17	100.0	
	Total	13	43.3	17	56.7	30	100.0	
Salt awareness	No	7	36.8	12	63.2	19	100.0	0.454
	Yes	6	54.5	5	45.5	11	100.0	
	Total	13	43.3	17	56.7	30	100.0	
Exercising Habits	No	5	29.4	12	70.6	17	100.0	0.165
	Yes	8	61.5	5	38.5	13	100.0	
	Total	13	43.3	17	56.7	30	100.0	

4. Discussion

The rate of nighttime blood pressure reduction by intermittent fasting was 43.3% in the patients included in our study. There was no variance in gender, age, comorbidities, smoking, alcohol consumption, BMI, waist circumference, sleep duration per day, salt awareness, and exercising habits between patients with and without reduced nighttime blood pressure. Baseline BW and BSA were higher, the duration of HT was longer, and the snacking habit was less in the group with improved blood pressure than in those without any improvement.

Animal studies have reported that intermittent fasting effectively lowers blood pressure (6). The study by Toledo et al. (8) divided 1422 individuals into four groups by administering 5, 10, 15, and 20-day intermittent fasting regimens for one year and reported that the mean SBP decreased from 131.6 ± 0.7 mmHg to 120.7 ± 0.4 mmHg and DBP from 83.7 ± 0.'4' mmHg to 77.9 ± 0.3 mmHg, while the SBP and DBP decreases were higher in the group treated with a longer intermittent fasting regimen. In a similar study by Erdem et al. (9) with 60 patients, a significant decrease was established in 24-hour ambulatory blood pressure measurements and office blood pressure measurements in all patients after 30 days of intermittent fasting. Li et al.'s (10) study with 32 type 2 DM patients reported a significant reduction in systolic/diastolic blood pressure measurements in all study patients after one week of intermittent fasting. In our study, nighttime blood pressure parameters were improved in 43.3% of the patients treated with intermittent fasting. Variances between study results may be due to different study groups and study periods.

Stote et al. (11) observed a reduction in systolic and diastolic blood pressure in all patients without gender variance after intermittent fasting in 15 cases (10 women and 5 men) with a mean age of 45 years. Toledo et al. (8) also established no gender variance in blood pressure reductions. In our study, the rate of improvement in blood pressure was 45.1% in women and 42.1% in men, and the variance was statistically unimportant.

Studies in various populations demonstrated an almost linear relationship between BMI and systolic and diastolic blood pressure. A BMI of <25 kg/m2 was found to be effective in the primary prevention of hypertension, and blood pressure was reduced with weight loss in most subjects (12). Intermittent fasting studies have shown that besides energy restriction, increased ghrelin and adiponectin levels, decreased leptin and insulin levels, and increased insulin sensitivity also cause weight loss and thus a decrease in BMI (13). It has been observed that current weight and the type and duration of intermittent fasting cause different rates of weight loss. A weight loss of 2.5–9.9% has been observed in almost all intermittent fasting studies (14,15). The study conducted by Toledo et al. (8) in 2019 determined that the waist circumference measurements of the participants decreased by 4.6 ± 0.1 cm in the 5-day intermittent fasting group and 8.8 ± 0.8 cm in the 20-day intermittent fasting group. Weight loss, in turn, was 3.2 ± 0.0 kg in the 5-day intermittent fasting group and 8.6 ± 0.3 kg in the 20-day intermittent fasting group. Weight loss and waist circumference reduction were considerably higher in men than in women. The authors found the patients with the highest body mass index to have the most weight loss. The study by Heilbronn et al. (14) reported a weight loss of 2.5% with 22-day intermittent fasting in 16 healthy individuals with normal body mass index, while Eshghinia and Mohammadzadeh (16) observed a weight loss of 7.1% in overweight or obese women with 6 intermittent fasting for 6 weeks. Our study administered intermittent fasting for one month and did not evaluate changes in weight, waist circumference, and body mass index. However, when the available measurements of the patients were compared, the

mean body weight was found to be considerably lower in the group without improvement in nighttime blood pressure parameters than in the group with improvement. The small size of our study group was the most significant factor for our adequate analysis and precise results.

The mechanism of blood pressure reduction in intermittent fasting was suggested to be connected to the augmented activation of the parasympathetic system due to the brain-derived neurotrophic factor (BDNF)-induced increase in NE excretion through the kidneys, increased renal sodium excretion, and increased insulin sensitivity (8,17). BDNF is mainly produced in response to the activation of glutamatergic receptors. Intermittent fasting is also a stimulant. The effect of the factor on heart rate and blood pressure has been proven in mice studies at George Washington University (18). A study by Sutton et al. with 130 prediabetes men established a mean decrease of 11 ± 4 mmHg in systolic blood pressure and 10±4 mmHg in diastolic blood pressure in patients after 18 hours/day fasting for 5 weeks (19). A prospective study conducted with 82 people during the month of Ramadan, in turn, reported no critical reduction in diastolic blood pressure but a decrease of 3 mmHg in systolic blood pressure (20).

Our study is important because it is one of the very few studies examining the effect of intermittent fasting on the course of blood pressure and the predictive factors of improvement in nighttime blood pressure parameters. However, it is limited by the single-center design, the reduced number of patients presenting to the hospital and the outpatient clinic during the COVID-19 pandemic, and the resistance of patients with an indication for a second 24-hour Holter monitoring of blood pressure against study participation due to concerns about the risk of COVID-19 transmission. In addition, biochemical parameters and anthropometric changes such as body weight, height, and BMI of the patients were not recorded one month later. Also, the lack of reporting energy intake and expenditure may affect the outcomes of intermittent fasting studies. There is a need for further multicenter studies on this subject in larger groups, administering a longer intermittent fasting regimen.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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Authors' contributions

Concept: A.H.Y.Y., A.A., B.K., D.A., Design: A.H.Y.Y., A.A., P.K., H.İ., Data Collection or Processing: A.H.Y.Y., A.A., P.K., H.İ., B.K., Analysis or Interpretation: A.H.Y.Y., A.A., D.A., P.K., Literature Search: A.H.Y.Y., A.A., B.K., H.İ., Writing: A.H.Y.Y., A.A., P.K., B.K.

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