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THE RELATIONSHIP OF MORNING SURGE in BLOOD PRESSURE and ATHEROGENIC INDEX

ATEROJENİK İNDEX İLE SABAH KAN BASINCI DALGALANMASI ARASINDAKİ İLİŞKİ

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ÖZET

Giriş: Sabah Kan Basıncı Dalgalanması (SKBD) fenomeni, sabah kan basıncında (KB) belirgin bir artış olarak tanımlanır. SKBD, kardiyovasküler hastalık (KVH) riskinde artışa ve tüm nedenlere bağlı ölümlere neden olur. Plazma aterojenite indeksi (PAİ), koroner ateroskleroz ve kardiyovasküler (KV) hastalık riskini tahmin etmek için kullanılır. Bu çalışmada SKBD ve PAİ arasındaki ilişkiyi incelemeyi amaçladık.

Yöntemler: Çalışmamıza ambulatuvar KB izlemesi olan 296 ardışık katılımcı dahil edildi. Hasta bilgileri hastane veri tabanından geriye dönük tarama yapılarak elde edildi. Elde edilen PAİ skoruna göre hastalar 3 gruba ayrıldı. SKBD ve PAİ risk grupları arasındaki ilişki incelenmiştir.

Bulgular: PAİ değeri hesaplandıktan sonra risk sınıflandırması yapıldı. Risk sınıflandırmasına göre; <0,11 düşük risk, 0,11-0,21 orta risk ve >0,21 yüksek risk. PAİ risk grupları ve SKBD değerleri karşılaştırıldı. SKBD ile PAİ arasında korelasyon saptandı. SKBD ile ilişkili parametreleri belirlemek için yapılan çoklu regresyon analizinde; yüksek risk grubunda yaş (p= 0,011), vücut kitle indeksi (VKİ) (p= 0,001), lenfosit düzeyi (p= 0,002), sigara içme (p= 0,024), erkek cinsiyet (p= 0,002), atriyal fibrilasyon (AF) (p= 0,018) ilişkili bulundu.

Sonuç: Çalışmamızın sonuçları artmış PAİ ve SKBD'nin bağımsız olarak ilişkili olduğunu göstermektedir. Yüksek PAİ puanı, artmış SKBD'yi gösterir. Ancak KVH açısından yüksek risk taşıyan hastalarda SKBD'nin bir tedavi hedefi olup olmayacağının belirlenmesi için gelişmiş çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: sabah kan basıncı dalgalanması, plazma aterojenite indeksi, kardiyovasküler hastalıklar.

ABSTRACT

Introduction: The Morning Surge Blood Pressure (MSBP) phenomenon is described as a marker an increase in morning blood pressure (BP). MSBP causes an increased risk of cardiovascular disease (CVD) and death from all causes. The atherogenic index of plasma (AIP) is used to predict the risk of coronary atherosclerosis and cardiovascular (CV) disease. In this study, we aimed to investigate the relationship between MSBP and AIP.

Methods: Our study included 296 consecutive participants with ambulatory BP monitoring. Patient data were obtained by retrospective scanning from the hospital database. The patients were divided into 3 groups according to the obtained AIP score. The relationship between MBPS and AIP risk groups was examined.

Results: After calculating the AIP value, risk classification was made. According to the risk classification; <0.11 low risk, 0.11-0.21 medium risk, and >0.21 high risk. AIP risk groups and MBPS values were compared. In the multiple regression analysis to determine the parameters associated with MSBP; age (p= 0.011), body mass index (BMI) (p= 0.001), lymphocyte level (p= 0.002), smoking (p= 0.024), male gender (p= 0.002), atrial fibrillation (AF) (p= 0.018) in the high-risk group.

Conclusion: Our retrospective study showed that increased AIP and MSBP are independently associated. A high AIP score indicates increased MSBP. However, prospective studies with large participation are needed to determine whether MSBP will be a treatment target in patients at high risk for CVD.

Keywords: morning surge blood pressure, plasma atherogenic index, cardiovascular diseases.

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INTRODUCTION

Cardiovascular diseases (CVD) are among the most common causes of mortality and morbidity (1). It causes the death of approximately 17 million people each year (2). High blood pressure (BP) is still an important reason of cardiovascular mortality.

BP shows a 24-hour course with lowest levels when asleep and higher levels when awake. The increase in BP during the transition from sleep to wakefulness is called morning blood pressure surge (MSBP) (3). In many studies, it has been shown that increased MSBP causes a risk for CVD and all-cause mortality (4). In the IDACO study conducted with 5645 patients, MSBP over 28 mmHg was found to be a risk factor for CVD (5).

The atherogenic index of plasma (AIP) is obtained with the logarithm of the ratio of the plasma triglyceride (TG) level to the high-density lipoprotein cholesterol (HDL-C) level (6) which associated with coronary atherosclerosis (7). In an observational study conducted with approximately 7000 patients in 2020, AIP was found to be independently associated with advanced subclinical coronary artery disease beyond traditional risk factors (8). In this study, we aimed to examine the relationship between MSBP and AIP.

METHODS

Our study included 296 consecutive participants who applied to the cardiology outpatient clinic in the last year and were followed up with ambulatory BP. The data of the participants were accessed from the hospital's digital database and recorded by retrospective scanning. Our study is compatible with the principles of the Declaration of Helsinki and approval was obtained from Pamukkale University's local ethics committee (10.01.2023/01).

Exclusion criteria were atrial fibrillation, coronary artery disease, heart failure, autoimmune diseases, malignancy, sleep apnea, acute and chronic renal failure, liver failure, chronic obstructive pulmonary disease, moderate and severe heart valve disease, pregnancy, statin users, hypothyroidism, and hyperthyroidism. Demographic characteristics and laboratory data were recorded by accessing the hospital database. Patients with systolic blood pressure (SBP) / diastolic blood pressure (DBP) above 140/90 mmHg on two or more measurements or using any antihypertensive medication were considered hypertensive (HT). Ambulatory BP measurement was recommended for patients defined as HT in office BP evaluation. Diabetes (DM) was defined as a fasting blood glucose above 126 mg/dL or a postprandial blood glucose above 200 mg/dL or a glycated hemoglobin level above 6.5% or using any antidiabetic. Echocardiographic evaluation was performed with a VIVID 7 echocardiography device in the left decubitus position for each patient. Heart dimensions and left ventricular ejection fraction calculated by the modified Simpson's method were recorded. We examined the relationship between MSBP and AIP.

Laboratory Parameters

Hemogram and biochemical parameters were taken from fresh blood samples taken after night fasting. Glucose was measured in plasma. Other parameters were studied in serum. Triglyceride, hemogram, kidney, and liver function panel, lipid parameters (total cholesterol, TG, HDL-C, LDL-C), and thyroid function tests were measured.

Calculation of Plasma Atherogenic Index

AIP was calculated [log (TG/HDL-C)] by taking the logarithm of the ratio of TG to HDL-C. AIP risk classification; According to the calculated values, it was defined as <0.11 low risk, 0.11-0.21 medium risk, and >0.21 high risk (6).

Office Blood Pressure Measurement

Office BP values were measured with an Omron MZ model (Omron Health Care, Mukou City, Kyoto, Japan) sphygmomanometer. HT was defined as SBP/DBP above 140/90 mmHg in two or more measurements or using any antihypertensive medication (9).

Ambulatory Blood Pressure Measurement

Ambulatory BP measurement was made with Mobil-O-Graph® NG-24h (hour) (I.E.M. GmbH, Stolberg, Germany). All patients recorded their sleep and waking times. Between sleeping and waking hours, night, other hours were considered as daytime and 24 hours were evaluated automatically. The mean BP in the first 2 hours after waking was defined as morning BP. The lowest BP was defined as the minimum night BP and the mean of the measurements before and after this BP. The lowest SBP among morning BP values was defined as MSBP.

Statistical analysis

Statistical analyzes of the study were performed with SPSS 20.0 (IBM Inc, Chicago, IL, USA) program. Descriptive statistics were presented as mean±SD for numerical variables, and frequency (percentage ratio) for categorical variables. Conformity of continuous numerical variables to normal distribution was checked with the Kolmogorov-Smirnov test. One-way Analysis of Variance was used for comparisons made according to AIP groups. Tukey HSD test was preferred as the post-hoc test for the results that were found to be significant. Chi-square analysis was used to

Table 1. Demographic Characteristics and Use of Drugs of the Patients

Variables		Plasma Atherogenic Index				
		<0.11	**0.11-0.21**	**>0.21**	**Total**	**p**
Age (Years) (m±SD)		51.54±17	54.79±14.9	54.38±14.23	54.07±14.66	0.527*
Gender	(Male)	8 (21.6)*	8 (24.2)	100 (44.2)*		**0.002****
	(Female)	29 (78.4)*	25 (75.8)	126 (55.8)*		
Weight (Kg) (m±SD)		69.92±13.1[a]	73.88±12.43	80.59±15.34[a]	78.51±15.24	**<0.001***
Size (Cm) (m±SD)		161.0±7.84	160.82±8.92[a]	164.89±10.54[a]	163.95±10.19	**0.017***
BMI (Kg/Cm^2) (m±SD)		26.92±4.6[a]	28.8±4.29	29.65±4.99[a]	29.22±4.94	**0.006***
Cigarette (n, %)		4 (10.8)	7 (21.2)	49 (21.7)		0.164**
Obesity (n, %)		10 (27.0)*	11 (33.3)	99 (43.8)*		**0.035****
ACEI-ARB (n, %)		14 (37.8)	18 (54.5)	96 (42.5)		0.964**
Beta-Blocker (n, %)		9 (24.3)	4 (12.1)	60 (26.5)		0.394**
Diuretic (n, %)		7 (18.9)	10 (30.3)	56 (24,8)		0.643**
Alfa-Blocker (n, %)		1 (2.7)	0 (0.0)	3 (1.3)		0.688**
CCB (n, %)		7 (18.9)	11 (33.3)	51 (22.6)		0.991**
HT (n, %)		23 (62.2)	21 (63.6)	141 (62.4)		0.983**
DM (n, %)		9 (24.3)	6 (18.2)	68 (30.1)		0,263**
COPD (n, %)		0 (0.0)	0 (0.0)	1 (0.4)		0.602**
AF (n, %)		2 (5.4)	0 (0.0)	6 (2.7)		0.567**

*: Significant at 0.05 level according to One-Way ANOVA test

[a,b,c] : Same superscript letters indicate significant pairwise comparisons at the p<0.05 level according to the TUKEY HSD test in One Way ANOVA.

: significant binary categories according to Chi-square test at 0.05 level. **Variables: m: Mean, SD: Standard deviation, BMI: Body mass index, ACEI-ARB: Angiotensin converting enzyme inhibitor-Angiotensin receptor blocker, CCB: Calcium channel blocker, HT: Hypertension, DM: Diabetes Mellitus, COPD: Chronic obstructive pulmonary disease, AF: Atrial Fibrillation

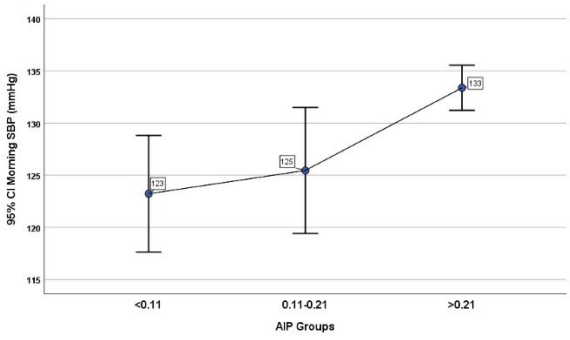
determine the relationships between categorical variables. Univariate and multivariate multiple logistic regression analyzes were applied to determine MSBP-related factors that were effective on AIP groups. Relationships between scores were analyzed by Pearson correlation analysis. A p<0.05 value was considered statistically significant for type-I error rate of 5% in all analyzes.

RESULTS

296 patients who underwent ambulatory BP follow-up for 24 hours participated in the study. 60.8% of the patients were women. The mean age was calculated as 54.07±14.65 years (Table 1). According to the AIP score; 37 patients were in the low-risk group, 33 patients were in the intermediate-risk group, and 226 patients were in the high-risk group (Table 1). While 44.2% of the male patients were in the high-risk group, 78.4% of the female patients were in the low-risk group (p=0.002) (Table 1). The weight and body mass index (BMI) values of the patients were correlated with AIP risk classes (p<0.001 and p=0.017, respectively). There was obesity in 110 patients, and 99 were in the high-risk group (p=0.035) (Table 1). The highest rate of HT was observed as an additional disease (62.5%). Normotensive status decreased according to risk groups (p=0.021) (Table 1). It was observed that as the AIP risk level increased, the HDL-C level decreased significantly, while the TG level increased significantly (p<0.001) (Table 2).

It was observed that 24-hour mean SBP and DBP values increased according to the AIP risk class (p=0.004 and p=0.016, respectively) (Table 2). It was observed that the mean values of SBP and DBP during the daytime and night also differed significantly according to the AIP risk groups (p<0.05) (Table 2). MSBP values were 26.37±11.50 mmHg in the low-risk group, 25.66±14.49 mmHg in the intermediate-risk group, and 29.17±12.65 mmHg in the high-risk group (p=0.026) (Table 2). Correlation was found between MSBP and AIP groups (Figure 1).

Figure 1. Correlation analysis between MSBP and AIP



Variables: MSBP: Morning surge blood pressure, AIP: Plasma atherogenic index.

Table 2. Laboratory and Ambulatory Blood Pressure Records Findings of the Patients

Variables	Plasma Atherogenic Index				
	<0.11	0.11-0.21	>0.21	Total	p
TC (mg/dl)	188.95±41.66	195.06±43.42	196.46±43.87	195.37±43.48	0.623*
HDL (mg/dl)	69.7±14.13	62.24±11.93	47.02±11.13	51.55±14.29	**<0.001***
LDL (mg/dl)	107.73±33.4	117.18±35.71	116.78±35.8	115.69±35.51	0.346
TRIG (mg/dl)	64.54±15.91[a]	91.27±16.98[b]	179.67±121.11[a,b]	155.43±114.88	**<0.001***
TSH (mıu / l)	1.7±1.23	1.9±0.91	1.74±1.01	1.75±1.03	0.656*
CRE (mg/dl)	0.8±0.16	0.8±0.15	0.82±0.16	0.82±0.16	0.450*
HB (g/dl)	13.66±1.4	14.15±1.07	13.86±1.63	13.86±1.55	0.408*
RDW (%)	13.75±1.02	13.66±1.44	13.97±1.27	13.9±1.26	0.315*
PLT (10^3/L)	259.95±69.2	253.64±69.37	273.49±83. 07	269.58±80.13	0.305*
LYMP (10^3/L)	2.11±0.57	2.44±0.73	2.44±0.97	2.4±0.91	0.128*
NEUT(10^3/L)	4.13±1.8	4.74±2.16	4.62±2.64	4.58±2.5	0.502*
LVEF (%)	60.54±2.58	60.76±3.09	60.18±3.59	60.29±3.43	0.596*
24 Hour SBP(Mmhg)	119.89±12.51[a]	121.61±14.12	126.94±13.7[a]	125.46±13.82	**0.004***
24 Hour DBP(Mmhg)	72.81±8.98[a]	73.36±9.43	77.4±11.42[a]	76.38±11.06	**0.016***
Daytıme SBP (Mmhg)	123.22±13.27[a]	124.88±13.97	130.01±13.69[a]	128.59±13.87	**0.006***
Daytime DBP(Mmhg)	75.05±9.4[a]	75.27±9.33	79.87±11.47[a]	78.76±11.16	**0,008***
Night SBP (Mmhg)	110.24±11.41[a]	113.24±15.45	118.15±15.33[a]	116.62±15.14	**0,005***
Nıght DBP ((Mmhg)	66.38±8.46[a]	68.15±10.83	71.33±11.91[a]	70.35±11.53	**0.027***
Mornıng SBP (Mmhg)	123.22±16.78[a]	125.45±17.04	133.38±16.5[a]	131.23±17	**<0.001***
Mornıng DBP (Mmhg)	75.14±12.58	77.27±8.68	84.55±35.47	82.56±31.62	0.145*
MSBP(Mmhg)	26.38±11.51	25.67±14.49	29.17±12.65	28.43±12.76	**<0.001***

*: significant at 0.05 level accordimg to One-Way ANOVA test

[a,b,c] :Same superscript letters indicate significant pairwise comparisons at the p<0.05 level according to the TUKEY HSD test in One Way ANOVA. **Variables:** TC:Total Cholesterol, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, TRIG: Triglyceride, TSH; Thyroid Stimulating Hormone, CRE: Creatinine, HB: Hemoglobin, RDW: Red blood cell distribution width, PLT: Platelet, LYMP: Lymphocyte, NEUT: Neutrophil, LVEF: Left ventricular ejection fraction, SBP: Systolic blood pressure, DBP: Diastolic blood pressure , MSBP: Morning surge blood pressure,

The AIP low-risk group was taken as the reference group. Multiple logistic regression models were created to identify MSBP-related factors that are effective in medium and high-risk groups. Age (OR: 1.033, 95% CI: 1.001-1.066; p = 0.042), BMI (OR: 1.112, 95% CI: 1.01-1.223; p = 0.030), and lymphocytes (OR: 2.151, 95% CI: 1.252-3.694; p = 0.006) were associated factors with MSBP in the intermediate risk group. (Table 3,4). Age (OR: 1.031, 95% CI: 1.007-1.056; p= 0.011), BMI (OR: 1.155, 95% CI: 1.068-1.248; p = 0.001), lymphocyte (OR: 2.069, 95% CI: 1.310-3.268; p =0.002), male gender (OR: 3.422, 95% CI: 1.565-7.482; p = 0.002), smoking (OR: 3.095, 95% CI: 1.158-8.264; p = 0.024) and AF (OR: 8.405, 95% CI: 1.441-49.033; p = 0.018) were related factors with MSBP in the high-risk group (Table 4).

DISCUSSION

In our study, we examined the relationship between MSBP and AIP. There was a statistically significant relationship between AIP risk groups and MSBP. In addition, according to PAI risk groups; age, BMI, a low lymphocyte level, active smoking, AF and male gender were factors associated with MSBP.

AIP is a novel index that is related to cardiovascular outcomes and calculated from log10 (TG/HDL-C). Many studies have found a high correlation between CVD and a strong predictor for future CV outcomes (10, 11). Dyslipidemia, a well-known risk factor for CVD, plays an important role for both TG and HDL-C in metabolic syndrome. It has been shown that lipid particles with high TG content contribute to both the formation and progression of atheromatous plaque (12). HDL-C particles have anti-atherosclerotic activity as well as reverse cholesterol transport function (13). The combination of increased TG level and decreased HDL-C levels is not only strongly associated with increased CVD risk, but also represents the lipid profile of overweight individuals. In the evaluation of advanced CAD in 6928 patients, AIP and subclinical CAD were found independent of traditional risk factors (14). Nam et al. found that AIP was a predictor of coronary artery calcification in individuals without known CVD (15). In another study, a high syntax score was found to be associated with AIP (16). In addition, in acute coronary syndrome patients under 35 years of age, disease severity and prevalence were correlated with AIP (17). In another study, AIP was found to be a strong marker in determining the future risk of CVD in patients with metabolic syndrome, HT, and type 2 DM (18). In our study, it was seen that 99 of 110 obese patients were in the high-risk class according to the AIP scoring. In addition, the patients in the high-risk group had more comorbidities than the other groups. Also, our findings may support the literature that AIP is a risk indicator.

Morning BP increase is a physiological condition, but an exaggerated morning BP increase is a CV risk. Therefore, the relationship between the degree of morning BP increase and CV risk is not linear, it has a threshold value. There are several prospective studies showing that increased morning BP is associated with CVD. In a study conducted on 519 elderly patients with HT; the incidence of stroke was found to be higher in patients with a BP fluctuation of >55 mm Hg during sleep (19). In another study, it was shown that there

Table 3. Univariate logistic regression model of MSBP-related factors in AIP groups

	Beta		***p***		**OR (95% CI)**	
Characteristics	**AIP (0.11-0.21)**	**AIP >0.21**	**AIP (0.11-0.21)**	**AIP >0.21**	**AIP (0.11-0.21)**	**AIP >0.21**
Age (Years)	0.043	0.033	**0.023***	**0.014***	1.044 (1.006-1.084)	1.034 (1.007-1.061)
BMI (Kg/Cm^2)	0.199	0.160	**0.012***	**0.012***	1.221 (1.045-1.426)	1.173 (1.036-1.329)
TC (Mg/Dl)	0.001	0.002	0.917*	0.599*	1.001 (0.990-1.011)	1.002 (0.994-1.010)
TSH(Mıu / L)	0.162	0.065	0.449*	0.696**	1.176 (0.773-1.778)	1.067 (0.771-1.475)
CRE (Mg/Dl)	-1.274	-1.181	0.490*	0.389	0.280 (0.007-10.446)	0.307 (0.021-4.507)
HB (G/Dl)	0.425	-0.104	0.054*	0.504*	1.530 (0.993-2.357)	0.901 (0.665-1.222)
RDW (%)	-0.126	0.010	0.585*	0.952*	0.882 (0.562-1.384)	1.010 (0.723-1.412)
PLT(10^3/L)	-0.006	0.002	0.124*	0.415*	0.994 (0.987-1.002)	1.002 (0.997-1.007)
LYMP (10^3/L)	1.042	0.814	**0.002***	**0.002***	2.835 (1.485-5.415)	2.257 (1.335-3.817)
NEUT (10^3/L)	0.097	0.054	0.467*	0.664*	1.102 (0.849-1.431)	1.055 (0.828-1.346)
LVEF(%)	0.002	-0.031	0.981*	0.526*	1.002 (0.872-1.151)	0.969 (0.879-1.068)
24 Hour SBP (Mmhg)	-0.369	-0.205	0.059*	0.161*	0.692 (0.471-1.015)	0.814 (0.611-1.085)
Daytime SBP (Mmhg)	0.244	0.133	0.100*	0.240*	1.277 (0.954-1.708)	1.142 (0.915-1.425)
Morning SBP (Mmhg)	0.007	-0.025	0.858*	0.354*	1.007 (0.929-1.092)	0.975 (0.925-1.028)
MSBP (Mmhg)	-0.020	0.061	0.560*	**0.049***	0.980 (0.915-1.050)	1.063 (1.000-1.130)
Gender	-0.401	1.775	0.603*	**0.001***	0.669 (0.147-3.040)	5.899 (1.993-17.455)
Cigarette	1.535	1.167	**0.021***	**0.030***	4.651 (1.259-17.241)	3.215 (1.121-9.174)
Obesity	0.955	0.095	0.179*	0.865*	2.599 (0.646-10.458)	1.099 (0.368-3.283)
CCB	1.326	-0.436	**0.024***	0.352*	3.759 (1.189-11.904)	0.647 (0.258-1.619)
HT	0.458	0.658	0.379*	0.093*	1.581 (0.570-4.389)	1.932 (0.896-4.166)
DM	0.877	0.179	0.124*	0.677*	2.404 (0.785-7.359)	1.195 (0.516-2.770)
AF	14.354	2.481	0.974*	**0.024***	1713492 (0.000-0.000)	11.956 (1.397-102.320)

*: significant at 0.05 level according to Univariate Logistic Regression OR: Odds Ratio, CI: Confidence Interval Variables: MSBP: Morning surge blood pressure, AIP: Plasma atherogenic index, BMI: Body mass index, TC: Total Cholesterol, TSH; Thyroid Stimulating Hormone, CRE: Creatinine, HB: Hemoglobin, RDW: Red blood cell distribution width, PLT: Platelet, LYMP: Lymphocyte, NEUT: Neutrophil, LVEF: Left ventricular ejection fraction, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, CCB: Calcium channel blocker, HT: Hypertension, DM: Diabetes Mellitus, AF: Atrial Fibrillation.

is a positive correlation between increased morning BP variability and CVD, independent of age and mean BP at 24 hours (20). In our study, patients with high CVD risk had higher 24-hour mean SBP and DBP, daytime SBP and DBP, night SBP and DBP, and morning SBP were higher. Our findings were similar to the literature.

In our study, 141 of 188 patients with hypertension were in the high-risk group of AIP. When evaluated in terms of pathophysiology; It can be thought that HT will affect MSBP by increasing vascular tone. At the time of admission, arterial blood pressure values were in the normotensive range. It is seen that the anti-HT treatment they have received has no positive effect on both MSBP and AIP.

The relationship between AIP and MSBP has not been studied before. There are some possible explanations for the relationship between high AIP and MSBP. First, endothelial dysfunction related to high AIP may cause decreased vascular elasticity, resulting in increased MSBP. Kivrak et al found that MSBP is related arterial stiffness (21). The second mechanism is increased sympathetic activity and oxidative stress which causes the release of vasoactive substances, inflammation cells, and free radicals increase. These, in turn, accelerate the atherosclerotic process in the vessel wall by increasing the release of small-density low-density lipoprotein (sdLDL). AIP is also a parameter that indirectly indicates sdLDL levels. In addition, increased MSBP was related with oxidative stress and paraoxonase 1 activity in HT patients (22).

Our study has some limitations. First, due to the cross-sectional design of the study, it does not provide prognostic information about this relationship. Second, although patients noted their sleeping and waking times, its reliability is questionable. Third, although we have determined the relationship between high AIP and MSBP, prospective studies with large participation are needed to support their cause-effect relationship.

In conclusion, our study revelad the positive relationship between AIP and MBPS which are the parameters related to cardiovascular risk factors for the first time. Controlling classical cardiovascular risk factors may seem to be effective in decreasing MSBP and AIP.

Table 4. Multivariate logistic regression model of MSBP-related factors in AIP groups

Characteristics	Beta		p		OR (95% CI)	
	AIP 0.11-0.21	AIP >0.21	AIP 0.11-0.21	AIP >0.21	AIP 0.11-0.21	AIP >0.21
Age (Years)	0.033	0.031	**0.042***	**0.011***	1,033 (1,001-1,066)	1.031 (1.007-1.056)
BMI (Kg/Cm^2)	0.106	0.144	**0.030***	**<0.001***	1,112 (1,011-1,223)	1.155 (1.068-1.248)
LYMP (10^3/L)	0.766	0.727	**0.006***	**0.002***	2,151 (1,252-3,694)	2.069 (1.310-3.268)
LVEF (%)	0.011	-0.019	0.862*	0.677*	1.011 (0.893-1.145)	0.981 (0.897-1.073)
24 Hour SBP (Mmhg)	-0.032	-0.024	0.716*	0.724*	0.969 (0.815-1.151)	0,976 (0,855-1,115)
Daytime SBP (Mmhg)	0.022	0.007	0.786*	0.907*	1.022 (0.871-1.201)	1.007 (0.890-1.141)
MSBP (Mmhg)	0.005	0.036	0.805*	**0.026***	1.005 (0.965-1.048)	1.036 (1.004-1.070)
Gender	0.261	1.230	0.615*	**0.002***	1.298 (0.469-3.589)	3.422 (1.565-7.482)
Cigarette	1.276	1.132	**0.035***	**0.024***	3.584 (1.092-11.764)	3.095 (1.158-8.264)

*: significant at 0.05 level according to Multivariate Logistic Regression,OR: Odds Ratio, CI: Confidence Interval, Variables: MSBP: Morning surge blood pressure, AIP: Plasma atherogenic index, BMI: Body mass index, LYMP: Lymphocyte, LVEF: Left ventricular ejection fraction, AF: Atrial Fibrillation

Ethics Committee Approval: Pamukkale University's local ethics committee approved this study (Number: 10.01.2023/01).

Informed Consent: Informed consent was provided from all patients who wanted participated in the study.

Authorship Contributions: Concept and design of article: OK, IB; Data Collecting: OK, IB; Writing: OK, IB; Drafting and critical revision of the article: OK, IB.

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