The Effects of Nocturnal Blood Pressure Paterns and Autonomic Alterations on Erectile Functions in Patients with Hypertension

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Abstract

Purpose: Hypertension (HT) is known to be of the main risk factors for erectile dysfunction (ED). But non-dipping (<%10 drop in the night) of HT is not investigated truly. The aim of this study was to test the hypothesis that the non-dipper hypertensive patients are more prone to develop erectile dysfunction.

Materials and Methods: This was a cross-sectional clinical study. 70 HT patients diagnosed by Ambulatory blood pressure monitoring (ABPM) were classified into 3 groups (No ED, mild to moderate and severe) according to their International Index of Erectile Function (IIEF) scores. All three groups were compared for their dipping status by ABPM, heart rate variability (HRV) by holter monitoring.

Results: In our study non-dipper hypertensives had statistically more erectile dysfunction (P=0.004). Also severe ED patients with non-dipping pattern had decreased dipping blood pressure levels then those of ED(-) patients with non-dipping HT (P= .003)(Daytime Systolic/Nighttime Diastolic Blood Pressure= 0.8 ± 0.07 / 3.90 ± 1.5, respectively). LF/HF daytime/ nighttime in holter reflecting sympathetic overactivity (P< .001).

Conclusion: Autonomic dysfunction especially sympathetic overactivity is associated with both non dipping pattern of HT and erectile dysfunction as a common pathologic pathway, besides there might be an association between ED and non dipping HT.

Key Words: Erectile dysfunction, non-dipper hypertension, sympathetic overactivity, heart rate variability, IIEF.

INTRODUCTION

Erectile dysfunction (ED) is one of the most common health problems especially in the elderly male.[1] Inadequate release and increased enzymatic destruction of nitric oxide (NO) or altered response of penile vascular smooth muscle cells to NO are the main etiologic factors of ED.[2] Nevertheless, many of factors which may have an effect on endothelial and regulatory autonomic functions can cause erectile dysfunction.[2] From that point of view, ED can be regarded as a marker of vascular and autonomic dysfunction. Virtually all cardiovascular risk factors including age, hypertension, diabetes mellitus, hyperlipidemia, smoking and obesity are risk factors which has a proven role on developing endothelial dysfunction.[3] Hypertension has a higher prevalence than the other cardiovascular risk factors and as a result of this, hypertension is one of the most important risk factor for ED. It seems that increasing in both severity and duration of hypertension can be a cause of endothelial dysfunction.[4] On the other hand, hypertension could also show complex characteristics and especially subtypes which are determined by nocturnal blood pressure alterations.[5]

Patients whose blood pressure does not decrease at least 10% during nocturnal period have been defined as non-dippers.[5] Many studies have shown that patients with essential hypertension with a non-dipper blood pressure pattern show an increased frequency of target organ damage.[6,7] It has also been suggested that there is more apparent endothelial dysfunction in hypertensive patients with a non-dipper profile.[8] Non-dippers have been shown to have lower levels of endothelium dependent vasodilatation than dippers, due to lower levels of NO release.[9]

Although there is extensive data about high ED prevalence in hypertensive patients. There is limited data about the relationship between circadian blood pressure alterations and erectile dysfunction.[10]

In the present study we aimed to determine the relationship between the blood pressure patterns and erectile dysfunction in hypertensive patients and possible associations of circadian autonomic changes.

MATERIAL AND METHODS

This is a cross-sectional study. 110 Male patients who admitted to the Cardiology Department for hypertension prediagnosis were screened in Andrology Department for erectile dysfunction. The study was carried out between April 2016 and April 2017 at the Medical Faculty of Kırıkkale University.

The study design was approved by the local ethics committee. Detailed information was given to enrolled patients, and informed consent forms were signed by all participants.

Patient selection

Those with systolic blood pressure above 140 mmHg and those with diastolic blood pressure above 90 mmHg were included in the study as hypertensive patients.

Exclusion criteria were acute coronary syndromes, systolic heart failure (EF<50%), coronary and peripheral artery disease , secondary hypertension, congenital heart disease, moderate and severe valvular heart disease, , thoracic/ abdominal aortic aneurysm, acute or a history of treatment for or diagnosis of carotid artery stenosis, chronic renal dysfunction (serum creatinine level >1.5 mg/dl), diabetes mellitus (fasting blood glucose level ≥126 mg/dl), malignancies, morbid obesity (body mass index [BMI] ≥40 kg/m2), asthma or chronic obstructive lung disease, infections, connective tissue disorders, neurological problems, psychiatric diseases (psychotic and major depressive patients and the patients with anxiety disorders), endocrine disease, alcohol and drug abuse and use of medications for hormonal treatment.

Forty patients were excluded because of progression of any exclusion criteria during the study period. In the present study, a total of 70 participants (Minimum age: 24, maximum age: 82, mean age: 55.0 ± 12.7 years) were enrolled into the study.

Laboratory

A fasting blood sample was drawn between 09.00 and 10.00 hours. Laboratory work-up involved detailed biochemical analysis including complete blood count, fasting blood glucose, urea, creatinine, ALT, AST and serum lipid profile (Total cholesterol, LDL cholesterol, HDL cholesterol, triglyceride).

Serum hormone levels were determined by electrochemiluminescence immunoassay with the Roche Elecsys 2010 immunoassay analyzer using Roche kit (Roche Diagnostic Corporation, Germany).

In case of necessity for differential diagnosis of erectile dysfunction hormonal analyses (luteinizing hormone (LH), prolactin, total testosterone (TT), free testosterone (FT), estradiol (E2) and dehydroepiandrostenedione-sulphate (DHEA-S))were performed additionally by using electrochemiluminescence immunoassay with the Roche Elecsys 2010 immunoassay analyzer using Roche kit (Roche Diagnostic Corporation, Germany).

Urologic and Andrologic evaluation

Erectile function evaluation: A specific Turkish-translated version of the International Index of Erectile Function (IIEF) questionnaire, i.e. erectile function (EF) domain, was used as the assessment instrument for measurement of EF and interventional efficacy.[11] The IIEF form was applied in all subjects for the assessment of sexual satisfaction by the Department of Urology.[12]

As the gold standard instrument, the IIEF is an extensively used and highly validated instrument for the evaluation of sexual function in men especially in clinical trials.[13] The EF domain is a six-item version of the IIEF questionnaire that grades EF by responses to six specific questions of the IIEF questionnaire; question 1–5 are related to EF segment of IIEF and the last question concerns erectile confidence, i.e. question 15 of the IIEF.[12,13] If IIEF score was less than 26, these patients were accepted as ED. According to IIEF values, erectile dysfunction is evaluated as following classification:

IIEF SCORE ≥26: No ED, IIEF SCORE 17–25: Mild ED, IIEF SCORE 11–16: Moderate ED, and IIEF SCORE <10: Severe ED.

Additionally, for the purpose of more detailed statistically analysis we also classified the scores of ED domain of IIEF as following:

Erectile dysfunction (ED) Groups:

Group 1[ED (-)]: IIEF score ≥26: No ED

Group 2 [ED (+)]: IIEF score 11-25: Mild -Moderate ED

Group 3[ED (+)]: IIEF score <10: Severe ED

Cardiologic evaluation: After obtaining detailed medical history, physical examination including blood pressure measurement in both arms by using sphygmomanometer was done in all subjects. 12-channel electrocardiography (ECG) recordings and transthoracic echocardiography (Ge-Vivid 7 Pro, General Electric; FL, USA) were performed.

Ambulatory blood pressure monitoring

We diagnosed essential hypertension by using ambulatory blood pressure monitoring (ABPM) (GE Tonoport, Berlin, Germany).

ABPM device was programmed to perform the measurement per 30 minutes in *Daytime* (06:00-22:00) and per 60 minutes in *Nighttime* (22:00-06:00).

After 24 hour blood pressure monitoring, recordings were processed by using Ge Tonoport Programme®. After that, evaluation of blood pressure levels were performed according to ESC/ESH 2013 Hypertension guidelines.[14] After the hypertension diagnosis, all participants were splited up as to dropping levels of blood pressure at the nighttime. Dropping levels of blood pressure is named as '' Dipping''. Additionally, the patients whose systolic blood pressure drop was over >%10 during the night period, were classified as ''Dipper Hypertension'', and the remainders were classified as ''Nondipper Hypertension'' [15]. Dipping is calculated by following formula:

Systolic Blood Pressure Dipping = [1- ($\frac{Mean\ Systolic\ Blood\ Pressure\ Nighttime}{Mean\ Systolic\ Blood\ Pressure\ Daytime}$)]X100

We also calculated Diastolic Blood Pressure dipping by using mean diastolic blood pressure night and daytime values in mentioned formula.

In the present study, 47 Dipper and 23 Nondipper patients were detected and then admitted the study.

Heart Rate Variability (HRV) measurements:

HRV measurements are related with R-R variations of a certain time period. It is well known that these measurements can reflect changes in autonomic states indirectly.[16]

Measurement of 24-Hour HRV: After the clinical and laboratory tests ended, a Holter device was affixed and starting time was adjusted to second sensitivity and when the recording time ends (24 hours) measurement of 24 Hour HRV was performed. Recordings were performed with 24-hour Holter monitoring and analyzed with Delmar-Impresario System (Delmar –

Impresario Medical Systems, Irvine, California, USA*)*.While evaluating the analyzed data, Standard measurement criteria was utilized as stated by Task Force Report in 1996.[16]

rMSSD was analyzed as the time domain HRV variables. RMSSD was described as square root of the mean differences between successive RR intervals. The unit of the time domain measurement is milliseconds (msec).[16]

Power spectral (frequency) analysis of HRV was also performed using a fast Fourier transform to break down the time series to its underlying periodic function. Total power (TP) was defined as the energy in the heart period power spectrum from 0 to 0.40 Hz. frequencies. The very low frequency (VLF) , low frequency (LF) and high frequency (HF) powers were defined as the energy in the heart period power spectrum between 0.003 - 0.04 Hz.,0.04 -0.15 Hz and 0.15 - 0.40 Hz, respectively. The unit of the frequency domain measurements is millisecond square $(msec)^2$.[16]

Then we calculated LF/HF (24 Hour) LF / HF ratio (Daytime), LF / HF ratio (Nighttime), LF / HF ratio (Daytime/Nighttime) ratios.

rMSSD reflects parasympathetic activity as the HF power in frequency domain data. LF/HF reflects sympathovagal balance and increasing in this ratio is considered that reflect increased sympathetic activity. [16]

In the present study, we used LF and HF, LF/HF ratio values as the frequency domain data and rMSSD value as the time domain data of HRV.

STATISTICAL ANALYSIS

All statistical analysis was performed using SPSS version 20.0 (SPSS; Chicago, IL, USA). The normally distributed data are presented as mean ± standard deviation (SD) and non-normally distributed data are expressed as median (25%-75%). For continuous data Student t

test with was used for comparing normally distributed data. Mann Whitney U test was used for comparing non-normally distributed data. Pearson and Spearman tests were used for correlation analysis. Univariate analysis type III was also performed for the evaluation of the factors which were of important associations with ED. A p value of <0.05 was accepted as statistically significant. Multivariate analyses were performed for comparing groups to show the effect of confounders and even interaction.

RESULTS

In the present study, a total of 70 participants were enrolled into the study (Minimum age: 24 , maximum age : 82, mean age 55.0 ± 12.7 years).

Table 1 and 2 shows that anthropometric characteristics of the patients that were admitted to the study. There were no differences in anthropometric measures, hormonal and biochemical tests between the patients with Dipper and Nondipper hypertension. Besides we did not detect any statistically significant between same measurements except age among the ED groups (P>0.05 and for age characteristic P<0.001, Student T test, Table 1 and 2).

In study group, there were 43 patients (%61.4) with Dipper hypertension, 27 patients (%38.6) with Nondipper hypertension. We detected that, there were 28 patients (%40.0) with normal erectile functions, 27 patients (%38.6) with mild-moderate erectile dysfunction and 15 patients (%21.4) with severe erectile dysfunction. There were only 6 patients with Nondipper hypertension have normal erectile functions. Furthermore, in the patient group which have severe erectile dysfunction (15 patients) , there were 11 patients with Nondipper hypertension. We determined that, there was statistically significant association between the presence of severe erectile dysfunction and Nondipper hypertension (P=0.004, Pearson Chi-Square).

There are statistically significant differences about mean systolic and diastolic pressure dipping between Dipper and Nondipper Hypertension groups (P<0.001 and P=0.001, Student T test, respectively). We also determined that there are statistically significant differences

about LF / HF ratio (Daytime), LF / HF ratio (Nighttime), LF / HF ratio (Daytime/Nighttime) values between Dipper and Nondipper Hypertension groups (*P*=0.014, *P*=0.050 and *P*<0.001, Student T test, respectively) . Additionally, we found that the patients with dipper hypertension have higher IIEF scores than those of the patients with Nondipper Hypertension (*P*=0.001, Student T test)(Table 3).

When we evaluated the ED groups, there are statistically significant differences about mean systolic and diastolic pressure dipping among ED groups (*P*=0.004, Kruskal Wallis test). After Bonferroni adjustment, we found that the patients with severe ED have lower dipping blood pressure measures than those of ED (-) group (*P*=0.002)(Table 4).

We also determined that there are statistically significant differences about LF / HF ratio (Nighttime) and LF / HF ratio (Daytime/Nighttime) values among ED groups (*P*=0.050 and *P*<0.001, Kruskal Wallis test, respectively) (Table 4).

Correlation analyses

We performed partial correlation analyses of IIEF Scores with HRV and ABPM measurements. After controlling the effects of age, weight, height, body mass index and waist circumference measures, there were positive correlation between IIEF Scores and LF/HF Ratio (Daytime/Nighttime) and Mean systolic blood pressure dipping (r: 0.371, *P*=0.014; r: 0.453, *P*=0.002, Partial correlation analysis, respectively). There was negative correlation between IIEF Scores and mean systolic blood pressure nighttime values (r:- 0.398, *P*=0.008; Partial correlation analysis, respectively).

We also performed univariate analysis to reveal the associations between IIEF Scores and HRV and ABPM results. According to univariate model which is of controlling the statistically affects of age, weight, height, body mass index, waist circumference, mean systolic blood pressure dipping measures, LF/HF Daytime/Nighttime ratios ; we determined that IIEF Scores have still shown statistically significant associations with mean systolic

blood pressure dipping and LF/HF Daytime/Nighttime ratio measures, age (F: 11.204, *P*=0.001; F: 6.199, *P*=0.015 and F: 4.458, *P*=0.039, Univariate analysis type III, *P*<0.05, respectively).

We used a multivariate analysis model, including IIEF score, age, height, weight, waist circumference, daytime and nighttime LF/HF ratios (sympathetic tonus), systolic and diastolic daytime and nighttime mean blood pressure ratios, daytime and nighttime HF (parasympathetic tonus) (Table 5). We determined that there is a close statically association between ED severity and blood pressure dipping levels at nighttime (F (Wilks' Lambda): 31.957)(*P*< 0.001) (Pairwise Comparisons, *P*= 0.004). The Odds ratio of ED for ABPM results were 6.36 (2.15-18.85)(P<0.001).

DISCUSSION

In the present study, we found that there was statistically significant relationship between the presence of ED and dipping characteristics of blood pressure in the patients with hypertension. According to our results, the patients with Nondipper hypertension which has strong association with more endothelial dysfunction and target organ damage have more severe erectile dysfunction symptoms than those of the patients with Dipper hypertension. We also determined that both the patients with Nondipper Hypertension and severe ED has higher sympathetic tonus compared to the patients with Dipper Hypertension. Besides, in our study, we detected that sympathetic overactivity may have a role in both Nondipper Hypertension and erectile dysfunction in the same time. Additionally, the most important result of our study about circadian autonomic dysfunction both in severe ED and Nondipper hypertension was decreased ratio of LF/HF Daytime / LF /HF Nighttime measures which reflects circadian sympathetic balance of autonomic nervous system.

Endothelial and autonomic functions have a key role to perform cardiovascular and metabolic functions with observable and measurable clinical and biochemical characteristics. Relaxation

and contraction capacities of arteries, peripheral and pulmonary vascular resistance and elasticity, blood pressure regulation, releasing and balancing of coagulant and anticoagulant agents, hormonal, metabolic and erectile functions are only a few of the processes that are made by contribution of vascular endothelial layer and autonomic nervous system. The relationship between endothelial dysfunction and hypertension is a well studied issue in last decade.[15, 17] There are a lot of studies in which endothelial dysfunction was to be one of the main pathophysiological process in hypertension and its related end organ damage.[15,17-19]

Hypertension is one of the most common diseases that is based on endothelial and autonomic dysfunctions. Additionally, it is well known that, endothelial and autonomic dysfunctions are also two of the most important reasons of erectile dysfunction. There are a lot of studies in the literature which reveal the high prevalence of erectile dysfunction in patients with hypertension.[20-23]

Nondipper hypertension is a clinical type of systemic hypertension that shows less than %10 decreases in nocturnal blood pressure levels. It is also related with high incidence of clinical complications which associate with target organ damages. Many of studies have shown that Nondipper hypertension has a close association with endothelial dysfunction left ventricular hypertrophy, increased proteinuria, secondary forms of hypertension, increased insulin resistance, and increased fibrinogen level.[24-25] However, Nondipper hypertension is not only related with endothelial and metabolic functions. In spite of having some contradictory results, it might depend on autonomic imbalance and pathological higher sympathetic activity in the patients with Nondipper Hypertension composed to those of Dippers.[26-28]

Additionally, it is a well known fact that erectile dysfunction is also closely related with autonomic dysfunction. Decreased parasympathetic and increased sympathetic activity are important factors of erectile dysfunction pathogenesis. Penile erection of nocturnal and early morning time which shows healthy erectile functions which closely depend on healthy

autonomic functions that reveal higher parasympathetic and lower sympathetic activity during nocturnal period. [29, 30]

According to our data, there was a statistically significant positive association between the presence of Nondipper hypertension and severe ED. The patients with severe ED have both higher mean nocturnal systolic and diastolic blood pressure levels and Nondipper blood pressure pattern. In our study, when we evaluated the heart rate variability measures, we also found that there were higher nocturnal sympathetic activity which is reflected by LF/HF ratio both in the patients with Nondipper hypertension and severe ED. Moreover, partial correlation analysis and univariate analysis results have shown that there were statistically significant associations between IIEF Scores and mean systolic blood pressure dipping and LF/HF Daytime/Nighttime ratio measures after controlling the effects of anthropometric characteristics. This data leads us to think that, both Nondipper hypertension and erectile dysfunction is closely related with autonomic dysfunction and higher incidence of erectile dysfunction in the patients with Nondipper hypertension might depend on autonomic dysfunction.

Limitations: We consider that major limitation of the present study is the absence of serum NO levels and being a small scale study.

CONCLUSIONS

In this study, we determined that, autonomic dysfunction might be effective on pathological processes of both Nondipper hypertension and ED. Besides, lower IIEF scores of the patients with Nondipper hypertension depend on autonomic dysfunction as a common pathological pathway.

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CONFLICT OF INTEREST

The authors report no conflict of interest.

Table 1: The statistically comparisons about anthropometric characteristics of patients with Dipper and Nondipper Hypertension

Patient Characteristics	Mean ± Standard Deviation(SD)	Dipper Hypertension N:43	Nondipper Hypertension N:27	P
Age (years)	54.97 ± 12.65	53.30 ± 12.68	57.63 ± 12.37	NS
Height (H)(cm)	172.04 ± 5.83	171.9 ± 5.5	172.2 ± 6.4	NS
Weight(W)(kg)	79.71 ± 9.95	79.8 ± 9.7	79.5± 10.5	NS
Body Mass Index (W/H^2)(kg/m^2)	26.94 ± 3.16	27.02 ± 3.20	26.79 ± 3.15	NS
Waist Circumference (cm)	97.31 ± 11.76	97.7± 12.0	96.8± 11.4	NS

Student T test, $p<0.05$, NS: Statistically Nonsignificant

Table 2: The statistically comparisons about anthropometric characteristics among erectile dysfunction groups

Patient Characteristics	Group 1 ED (-) No ED N:28	Group 2 ED (+) Mild-Moderate N:27	Group 3 ED (+) Severe N:15	P
Age (years)	48.07 ± 11.02	57.44 ± 11.97	63.40 ± 10.29	<0.001
Height(H) (cm)	173.79 ± 5.35	171.59 ± 6.97	169.60 ± 3.09	0.069
Weight(W) (kg)	81.04 ± 9.41	79.59 ± 11.01	77.47± 9.13	0.539
Body Mass Index (W/H^2)(kg/m^2)	26.87 ± 3.23	27.00 ± 3.07	26.96± 3.39	0.989
Waist Circumference (cm)	95.00± 10.74	98.96± 12.34	98.66± 12.56	0.410

One Way ANOVA test, $p<0.05$, NS: Statistically Nonsignificant; ED, Erectile dysfunction.

Table 3: The statistically comparisons about ambulatory blood pressure monitoring (ABPM) measurements, heart rate variability and IIEF scores of patients with Dipper and Nondipper Hypertension

Patient Characteristics	Dipper Hypertension N:43	Nondipper Hypertension N:27	P
Ambulatory blood pressure monitoring (ABPM) measurement			
Mean systolic blood pressure (24 Hour)(mmHg)	144.5 ± 13.5	146.7 ± 7.9	0.447
Mean diastolic blood pressure (24 Hour) (mmHg)	87.0 ± 11.3	88.2 ± 6.3	0.618
Mean systolic blood pressure (Daytime) (mmHg)	148.1 ± 13.1	147.1 ±7.6	0.676
Mean diastolic blood pressure (Daytime) (mmHg)	89.8 ± 11.1	89.4 ± 6.9	0.872
Mean systolic blood pressure (Nighttime) (mmHg)	131.2 ± 11.5	144.3 ± 12.0	<0.001
Mean diastolic blood pressure (Nighttime) (mmHg)	78.0 ± 11.9	84.4 ± 7.8	0.019
*Mean systolic pressure Dipping (%)	13.66 (11.62-15.17)	0.40 (2.52 - 6.30)	<0.001
*Mean diastolic pressure Dipping(%)	14.73 (9.00-18.31)	3.18 (0.90 -11.71)	0.001
Heart rate variability measurements (Frequency domain)			
*Low frequency (LF) (24 Hour) (msec)^2	238.0 (137.5-603.2)	347.6 (157.4-554.5)	0.629
*High frequency (HF)(24 Hour) (msec)^2	111.2 (48.3-181.5)	111.28 (80.26-226.7)	0.463
*LF/HF (24 Hour)	2.75 (1.50 - 4.44)	2.31(1.75-3.98)	0.963
*Low frequency (LF) (Daytime)(msec)^2	267.1(131.9-500.3)	284.8 (122.53-451.5)	0.668
*High frequency (HF)(Daytime)(msec)^2	62.6 (26.4-113.8)	75.4 (36.7-128.5)	0.663
*LF/HF (Daytime)	4.44 (3.08-6.20)	3.15 (1.92-4.28)	0.014
*Low frequency(LF)(Nighttime)(msec)^2	378.6 (175.5-627.0)	316.6 (135.1-194.7)	0.405
*High frequency(HF)(Nighttime)(msec)^2	159 (121.4-182.6)	179.4 (136.9-435.9)	0.132

*LF/HF (Nighttime)	1.89 (1.42-2.65)	3.50 (1.74-4.69)	0.050
*LF/HF (Daytime/ Nighttime ratio)	2.20 (1.36-3.37)	0.83 (0.56-1.39)	<0.001
Heart rate variability measurements (Time domain)			
* rMSSD(24 Hour) (msec)	28.0 (19.0-37.0)	26.0 (22.5-38.0)	0.810
* rMSSD(Daytime) (msec)	42.7 (28.2-72.8)	37.5 (23.9-51.2)	0.777
* rMSSD(Nighttime) (msec)	48.7 (25.5 - 80.4)	39.3(27.8-60.8)	0.145
IIEF SCORE			
IIEF	23.28 ± 6.56	14.33 ± 9.56	<0.001

Student T test, Mean±SD, p<0.05, *Mann Whitney U test, Median (%25-%75),p<0.05, NS: Statistically Nonsignificant; ABPM, Ambulatory blood pressure monitoring; IIEF, International Index of Erectile Function.

Table 4: The statistically comparisons about ambulatory blood pressure monitoring (ABPM) measurements, heart rate variability and IIEF scores erectile dysfunction (ED) groups

Patient Characteristics	Group 1 ED(-) No ED N:28	Group 2 ED(+) Mild-Moderate N:27	Group 3 ED(+) Severe N:15	P
Ambulatory blood pressure monitoring (ABPM) measurements				
Mean systolic BP (mmHg)(24 Hour)	146.0 ± 11.95	142.29 ± 10.31	150.39 ± 11.42	0.096
Mean diastolic BP (mmHg) (24Hour)	89.19 ± 10.18	85.09 ± 9.27	89.55 ± 8.12	0.223
Mean systolic BP (mmHg)(Daytime)	148.08± 10.56	144.74 ±9.72	152.10± 11.84	0.099
Mean diastolic BP (mmHg) (Daytime)	92.45 ± 10.37	86.79 ± 8.53	90.82 ± 8.82	0.109
Mean systolic BP(mmHg) (Nighttime)	129.72± 10.55	133.24 ± 13.57	144.15 ± 14.36	0.003
Mean diastolic BP(mmHg) (Nighttime)	80.11 ± 9.25	78.34 ± 11.94	85.95 ± 9.18	0.095
*Mean systolic pressure Dipping (%)	13.03 (10.66-13.04)	10.98 (1.58 - 13.79)	4.28(1.70 - 10.85)	0.004
*Mean diastolic pressure Dipping (%)	13.15 (7.33-18.05)	11.74 (1.16 - 17.38)	4.49(1.66-11.76)	0.045
Heart rate variability measurements (Frequency domain)				
*Low frequency (LF) (24 Hour)(msec)^2	359.2 (174.9-577.3)	231.8 (124.3-668.6)	234.1(134.8-531.5)	0.629

*High frequency (HF) (24 Hour)(msec)^2	136.3(93.0-263.2)	108.1(38.4-187.1)	101.4 (51.7-163.3)	0.463
*LF/HF (24 Hour)	2.17(1.55-3.83)	3.11 (1.86-5.15)	2.31 (1.07-5.12)	0.963
*Low frequency (LF) (Daytime)(msec)^2	284.8 (140.1-470.1)	307.7 (126.6-533.5)	196.8 (102.5-389.8)	0.668
*High frequency (HF) (Daytime)(msec)^2	75.4 (28.2-143.3)	61.7 (33.8-121.5)	67.6 (24.4-113.8)	0.663
*LF/HF (Daytime)	3.77 (3.12-6.0)	3.83 (2.60-4.44)	3.09 (1.86-4.69)	0.014
*Low frequency (LF) (Nighttime)(msec)^2	349.4 (173.4-510.9)	347.6 (208.0-688.4)	293.7 (106.4-488.8)	0.405
*High frequency (HF)(Nighttime)(msec)^2	217.4 (63.3-321.1)	203.8 (85.1-330.9)	59.1(31.3-184.9)	0.132
*LF/HF (Nighttime)	1.66 (1.24-2.43)	1.98 (1.45-4.16)	3.70 (2.65-5.14)	0.050
*LF/HF (Daytime/ Nighttime ratio)	2.36 (1.36-3.34)	1.88 (1.01-3.27)	0.72 (0.35-1.64)	<0.001
Heart rate variability measurement (Time domain)				
*rMSSD(24 Hour) (msec)	29.0 (23.0-321.1)	26.0 (17.5-33.5)	25.0(18.0-41.0)	0.810
* rMSSD(Daytime) (msec)	40.2 (25.8-62.9)	27.0 (20.6-43.3)	27.3(20.2-39.5)	0.777
* rMSSD(Nighttime) (msec)	48.3 (31.5-80.7)	37.1 (26.2-53.4)	30.6(22.0-51.5)	0.145
IIEF SCORE				
IIEF	28.0± 1.9	18.9 ± 4.4	6.1± 3.7	<0.001

One Way ANOVA test, Mean±SD, $p<0.05$, *Kruskal Wallis test, Median (%25-%75), $p<0.05$,

NS: Statistically Nonsignificant, BP: Blood pressure. ABPM, Ambulatory blood pressure monitoring; IIEF, International Index of Erectile Function.

Table 5: The results of multivariate analysis

Patient Characteristics	F- values	P- values
Age (years)	0.169	0.845
Height (H) (cm)	2.688	0.082
Weight (W)(kg)	2.857	0.071
Waist Circumference (cm)	1.925	0.161
High Frequency (HF)(Daytime)$(msec)^2$	3.178	0.054
Low Frequency (LH) / High Frequency (HF) (Daytime)	0.399	0.674
High Frequency (HF)(Nighttime)$(msec)^2$	2.738	0.078
LF/HF (Nighttime)	1.905	0.236
LF/HF(Daytime/ Nighttime ratio)	0.787	0.463
ED Severity	31.957	<0.001