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Morning Blood Pressure Surge and it's Relation to Hypertensive end Organ Damage and Severity of Coronary Artery Disease

Thulaseedharan Sarojadevi Ashida[1], Rajagopal Sriram[2], Rangasamy Balamurugan[3]

Authors Affiliation:
[1]Assistant Professor, Department of Cardiology [3]Research Scientist, Central Research Laboratory, Sri Manakula Vinayagar Medical College and Hospital, Puducherry 605107, India. [2]Chief Cardiologist, Department of Cardiology, Southern Railway Head Quarters hospital, Ayyanavaram, Chennai, Tamil Nadu 600023, India,

Corresponding Author:
Ashida T.S,
Assistant Professor, Department of Cardiology, Sri Manakula Vinayagar Medical College and Hospital, Puducherry 605107, India.

Email: drashidats@gmail.com

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Abstract

Background: Elevated blood pressure is an independent predictor of cardiovascular disease. Hypothesis: Hypertensive patients with apparently normal clinic blood pressure recordings can have abnormal Ambulatory Blood Pressure Monitoring (ABPM) profiles like nondipping and morning blood pressure surge. Abnormal ABPM profiles especially Morning blood pressure surge (MBPS) are associated with more severe hypertensive end organ damage and coronary artery disease. *Methods:* Fifty hypertensive patients with documented coronary artery disease and well controlled clinic blood pressure measurements who underwent successful ABPM recordings were included in the study. MBPS and dipping profiles were analyzed. The abnormal ABPM profiles were correlated with hypertensive end organ damage and coronary artery disease severity assessed by Gensini score. *Results:* 96% of the patients were nondippers. 62% of the patients showed morning blood pressure surge when calculated using sleep-trough morning surge. Patients with MBPS had higher LV mass and more hypertensive retinopathy. The severity and extent of coronary artery disease by Gensini score was significantly higher in the MBPS group (59.74±31.35 vs 24.84±28.36) with a P value of 0.0002) *Conclusion:* A significant proportion of hypertensive patients with well controlled clinic blood pressure recordings have exaggerated MBPS and nondipping blood pressure profile identified by ABPM. MBPS is associated with more severe hypertensive target organ damage and coronary artery disease assessed by Gensini scoring system and is independent of the dipping status. In addition to anti-platelet medications, statins and lifestyle modifications, antihypertensive therapies targeting MBPS may help in preventing cardiovascular disease progression in hypertensive patients.

Keywords: Ambulatory Blood Pressure Monitoring; Morning Blood Pressure Surge; Non-Dipping; Hypertensive End Organ Damage; Coronary Artery Disease; Gensini Score.

Introduction

Hypertension is one of the major risk factors of coronary artery disease. Patients with apparently normal clinic blood pressure readings can have abnormal blood pressure profiles during ambulatory blood pressure recordings which put them at risk of hypertensive end organ damage and future cardiovascular events. The study done by Millar Craig et al. [1] using continuous intra arterial recording showed circadian variation in blood pressure with nocturnal dipping and morning surge. Studies have shown that average ambulatory blood pressure levels over 24 hours have better correlation with hypertensive target organ damage and cardiovascular events than clinical blood pressure [2]. Abnormal ambulatory blood pressure profiles commonly studied include Non dipping and morning blood pressure surge. Compared to awake values a 15-25% nocturnal decrease of blood pressure occurs normally. A non-dipping blood pressure profile is defined as a nocturnal blood pressure fall of less than 10% and has shown proven association with more severe hypertensive target organ damage and increased cardiovascular risk [3].

Awakening from sleep results in activation of sympathetic nervous system and a sharp rise in blood pressure values [4,5]. Morning blood pressure surge is defined as the difference between the mean systolic blood pressure during the two hours after waking and arising minus the mean systolic pressure during the hour that included the lowest blood pressure during sleep [6].

Methodology

Fifty consecutive hypertensive patients with documented coronary artery disease by coronary angiogram attending the cardiology out patient department with well controlled clinic blood pressure recordings were included in the study after getting informed consent. Clinic Blood Pressure (BP) was measured after resting for at least five minute in the sitting position and was measured for each patient on 3 or more occasions on different days. Patients with average clinic systolic blood pressure (SBP) ≤ 130 mm hg and average clinic diastolic blood pressure (DBP) ≤ 90 mm Hg were considered to have well controlled clinic BP recordings. Hypertensive patients with congestive heart failure, atrial fibrillation, diabetes mellitus and patients on anticoagulant medications were excluded.

All patients underwent trans-thoracic echocardiogram using Philips IE-33 echocardiography machine. Left ventricular (LV) mass was calculated using the Devereux formula. The E/A ratio of mitral inflow was measured using pulsed wave Doppler to assess diastolic function. Left ventricular Ejection fraction was measured using the area length method. Fundus examination was done by ophthalmologist for evidence of retinopathy.

All patients underwent twenty four hour ambulatory blood pressure monitoring (ABPM) with Del MAR Reynolds Medical Pressurometer Model P6 that was programmed to record BP and pulse rate every 15 minutes during the day and thirty minutes during the night by oscillometric method. A successful ambulatory blood pressure recording was defined if at least 90% of recordings were obtained. The wakeup time and arising time (time of getting out of the bed) was recorded by all patients by diary card entry.

Sleep blood pressure was defined as the average of blood pressure recordings from the time patient went to bed until the time he or she got out of bed. Awake blood pressure was defined as the average of blood pressures recorded during the rest of the day.

Morning blood pressure was defined as the average of BPs during the first 2 hrs after wake-up time. The lowest blood pressure was defined as the average BP of 3 readings centered on the lowest night time reading. Preawake blood pressure was defined as the average BP during the 2 hours just before wakeup time(4 BP readings).

The Morning blood pressure surge(MBPS) was calculated in two ways.

1. Sleep-trough MBPS, defined as the morning SBP minus the lowest SBP and

2. Pre-awake MBPS, defined as the morning SBP minus the preawake SBP.

A morning blood pressure surge ≥ 30 mmHg was used as the cutoff value to divide the patients into MBPS and non MBPS groups [7].

Nocturnal dipping was calculated as the percentage fall of the systolic mean BP from day to night. Normal dipping was defined as 10-20% fall, non dipping as <10% fall and overdipping as > 20% fall in night BP. The systolic pressures were used for all these calculations.

Coronary angiogram was reviewed and classified as single, double and triple vessel disease. Severity of coronary artery disease was also assessed by Gensinis coronary artery scoring method [8]. Sample size was calculated for a p value of 0.05

Results

50 patients were enrolled in the study. The mean age of the population was 54.9±6.9 years. Males were 33.The duration of hypertension was 4.34±2.26 years. The Body Mass Index (BMI) was 25.82±2.13 kg/m^2 (Table 1). The Clinic blood pressure was well controlled and the mean systolic BP was 116.84±6.76 mmhg and the mean diastolic BP was 74.6±5.03 mmhg. Hypertensive retinopathy was seen in 33 (66%) patients, diastolic dysfunction in 32 patients (64%) and the mean LV mass was 177.64±17.83gm.

The mean Day systolic BP by ABPM was 116.88±14.96 mmhg which was not significantly different from the clinic systolic BP which was 116.84±6.76 (p=0.29 by Mann-Whitney test)

The morning systolic BP (mean of SBP of the first two hours after wake up time) was 121.50±16.86 mmhg and was higher than the clinic systolic BP of 116.84±6.76 mm hg but the difference was not statistically significant (p=0.08).

The pre awake systolic BP (mean of the SBP of the first two hours before wake up time) was

108.75±18.01 mmhg, which was significantly lower than the clinic SBP. (p value of 0.001). The Day Systolic BP was 116.68±14.96 mmhg and was not significantly different from the night systolic BP at 112.14±15.69 mm hg (p=0.12 by unpaired t test) (Table 2).

MBPS

Of the 50 patients studied, thirty one had Morning BP surge (group 1-MBPS) and the remaining patients did not have MBPS (Group II-Non MBPS) The two groups did not differ with respect to baseline characteristics like age, sex distribution, BMI, duration of hypertension and smoking. LV ejection fraction was normal in both groups.

LV mass was significantly higher in Group I (182.39±18.09gm) compared to group II (169.89±14.75gm) with a p value of 0.014 on unpaired t test. Hypertensive retinopathy was more common in Group I (80%) when compared to group II (42%) and this difference was statistically significant p=0.012 by Fishers exact test (Table 3).

The prevalence of diastolic dysfunction did not differ significantly in both groups.

Table 1: Baseline Characteristics

Parameter	Group I (MBPS) (N=31)	Group II (Non MBPS) (N=19)	P value (Statistical Test)
Age (Yrs)	54.96±6.8	54.42±7.3	P=0.79 (Unpaired t test
Gender (M:F)	23:8	10:8	P=0.35 (Fishers Exact Test)
Body Mass Index (Kg/m2)	25.52±1.73	26.31±2.64	P=0.25 (unpaired t test)
Duration of Hypertension (Yrs)	4.39±2.39	4.26±2.06	P=0.84 (Unpaired t test)
Smokers (n)	14	4	P=0.13 (Fishers Exact Test)
LV Ejection Fraction(%)	62.35+5.09	62.96±6.31	P=0.73 (Unpaired t test)

Table 2: Ambulatory Blood Pressure Data

Parameter	Group I (MBPS) (N=31)	GroupII (Non MBPS) (N=19)	P value (Statistical Test)
Morning Bp (mmHg) (Mean of SBP of the first two hours after Wake up time)	127.17±15.50	112.24±15.02	P=0.0016 (Unpaired t test)
Lowest Bp (mmHg)	92.58±14.85	101.37±14.01	P=0.043 (Unpaired t test)
Pre Awake BP (mmHg) (Mean of SBP of the first two hours after Wake up time)	109.18±19.83	108.04±15.05	P=0.82 (Unpaired t test)
Morning Rise/hr (mmHg/hr)	6.76±2.43	4.52±3.45	P=0.0106 (Unpaired t test)
Day SBP (mmHg)	118.03±16.70	115.00±11.78	P=0.4925 (Unpaired t test)
Night SBP (mmHg)	113.23±17.45	110.37±12.55	P=0.5376 (Unpaired t test)
Pulse pressure (mmHg)	47.19±12.03	44.53+8.20	P=0.8027 (Mann Whitney Test)
Sleep-trough MBPS (mmHg)	34.76±5.06	10.98±6.41	P<0.0001 (Unpaired t test)

Table 3: Hypertensive Target Organ Damage

Parameter	Group I (MBPS) (N=31)	GroupII (Non MBPS) (N=19)	P value (Statistical Test)
Patients with Diastolic Dysfunctoin N(%)	19(61%)	13 (68%)	P=0.76 (Fishers Exact Test)
LV Mass (gm)	182.39±18.09	169.89±14.75	P=0.014 (Unpaired t test)
Patients with Hypertensive Retinopathy N(%)	25(81%)	8 (42%)	P=0.012 (Fishers Exact Test)
Creatinine (mg/dl)	0.96±0.19	0.92±0.23	P=0.57 (unpaired t test)

Table 4: Coronary Artery Disease By Gensini Score

Parameter	Group I (MBPS)	GroupII (Non MBPS)	P value (statistical Test)
Gensini Score	59.74±31.35	24.84±28.36	P=0.0002 (Unpaired t test)

MBPS and severity of CAD

45% of patients had triple vessel disease in group I and 11% in group II. The percentage of patients with double vessel disease was 32% and 26% respectively.22% in group I and 63% in group II had single vessel disease.

The severity and extent of coronary artery disease by Gensini score was significantly higher in the MBPS group (59.74±31.35 vs 24.84±28.36) with a P value of 0.0002) (Table 4).

Discussion

This was a descriptive study of ambulatory blood pressure profile in 50 patients with well controlled clinic BP recordings with special reference to morning blood pressure surge.

Although the clinic blood pressure recordings were well controlled, ABPM showed an abnormal profile. 62% of the patients showed MBPS when calculated using sleep-trough morning surge. The pre- awake blood pressure surge was not significant. Studies have shown sleep trough MBPS to be more sensitive and correlate better with clinical events compared to pre awake blood pressure surge.

Among the 50 patients 96% showed a non dipping profile. Two (4%) of them were dippers and there were no extreme dipper.

Various studies have shown that abnormal Ambulatory blood pressure profile is an independent determinant of hypertensive target organ damage. Kuwajimai et al. [9] conducted an echocardiographic study and ambulatory blood pressure monitoring in twenty three elderly hypertensive patients to evaluate the relationship between hypertensive cardiac damage and morning blood pressure surge. The change in systolic blood pressure after arising from bed was correlated significantly with the LV mass index ($p< 0.02$)and the E/A ratio. In this study patients with morning blood pressure surge had a higher LV mass when compared to those without MBPS (p value of 0.014 on unpaired t test)suggesting more severe cardiac damage. Though majority of patients were non-dippers, this was not different between the two groups suggesting an independent role of MBPS. As in the study by Kuwaijimai et al., preawake blood pressure did not account for the difference in LV mass as it did not differ in both the groups.

Hypertensive retinopathy was significantly more in the MBPS group (80% vs 42%).

Abnormal ABPM profiles have been correlated with increased prevalence and severity of coronary artery disease. In a study of 68 men with documented coronary artery disease and 68 controls by Mousa et al. [10] non dipping was associated with coronary stenosis independent of other clinical parameters.

In a study of 100 patients who underwent coronary angiography Konstandonis et al. [11] correlated abnormality of Ambulatory blood pressure and severity of coronary atherosclerosis measured using Gensinis scoring system. More extensive coronary artery disease was seen in patients with an abnormal ABPM profile.

Conclusion

A significant proportion of hypertensive patients with well controlled clinic blood pressure recordings have exaggerated morning blood pressure surge and nondipping blood pressure profile identified by ambulatory blood pressure monitoring.

The sleep trough morning blood pressure surge can be used to identify the patients with an exaggerated morning blood pressure surge.

Morning blood pressure surge is associated with more severe hypertensive target organ damage and is independent of the dipping status.

Patients with morning blood pressure surge have more severe coronary artery disease assessed by Gensini scoring system

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