Patients with Dipper and Nondipper High-Normal Blood Pressure Were Associated with Left Ventricular Mass

Fan-kai Xiao,1,2 Ping Li,3 Zhan-ying Han,2 Li Jing,2 Shaohua Hua,4 and Luo-sha Zhao2

1Oncology Department, The First Affiliated Hospital of Zhengzhou University, Zhengzhou, China
2Department of Cardiology and Hypertension, First Affiliated Hospital of Zhengzhou University, Zhengzhou, China
3Henan Medical College, Zhengzhou, China
4Department of Ultrasound, The First Affiliated Hospital of Zhengzhou University, Zhengzhou, China

Correspondence should be addressed to Luo-sha Zhao; zls319@hotmail.com

Received 24 September 2021; Accepted 6 December 2021; Published 21 December 2021

1.Introduction

According to the 2020 international hypertension guideline, high-normal blood pressure was defined as systolic BP between 130 and 139 mmHg and/or diastolic BP between 85 and 89 mmHg based on 2 or more properly measured seated BP readings on each of 2 or more office visits [1]. Report from Yuli indicated that high-normal blood pressure has increased the risk of cardiovascular disease after adjusting for multiple factors even in low range; meanwhile, it is also harmful to end-stage renal disease or chronic kidney disease, fundus lesion, and endothelia cell abnormality [2].

Recently, although, 24-hour ambulatory blood pressure monitoring (ABPM) was recommended to apply for the prevention, evaluation, detection, and treatment of both high-normal blood pressure and hypertension in patients [3]. There is less investigation on the impact of high-normal BP on LV mechanics or left ventricular hypertrophy through ABPM.

We aimed to find the relation between LVMI and high-normal blood pressure in both dipper and nondipper through analysis of high-normal blood pressure and normotensive by ABPM.

1.1. Patients and Methods. Recruitment: 146 consecutive patients who were diagnosed to high-normal blood pressure and 35 normotensive people who took general cardiovascular check-up from the cardiology outpatient clinic in the
First Affiliated Hospital of Zhengzhou University were involved. According to the 2020 ISH Global Hypertension Practice Guidelines, based on expert opinion, panel recommends systolic BP between 130 and 139 mmHg and/or diastolic BP between 85 and 89 mmHg [1]. We choose normotensive groups aged from 18 to 50 years old, systolic pressure under 130 mmHg, and diastolic blood pressure under 85 mmHg. The standard of high-normal blood pressure followed 2020 ISH Global Hypertension Practice Guidelines, those with SBP 130–139 mmHg or DSB 85–89 mmHg. Exclusive criteria were diabetes, chronic kidney disease, coronary artery disease, peripheral artery disease, heart failure, previous stroke, and unwilling to provide written informed consent. 181 people (146 high-normal blood pressure and 35 normotensive) who were eligible to the above condition and exclusive criteria were enrolled. Then, according to the results of ABPM, the high-normal blood pressure group could be divided into the dipper group (n = 77) and nondipper group (n = 69).

Procedure: recorded the age, sex, height, body mass index (BMI), heart rate, blood pressure, fasting blood glucose (FBG) lipid, liver function test, renal function test, routine blood test, whether smoke, whether have hypertension family history or not, and electrocardiograph (EGC).

BP measurements were taken in the sitting position after 5 minutes of resting using nondominant arm kept in the same line with the heart. DBP and SBP were calculated twice in different days, and record the average of them.

The FDA and CE certified ambulatory blood pressure monitoring (ABPM) (CONTEC, China) [4, 5] (https://contecmedical.en.made-in-china.com/product/TSLAewYpqgpk/China-Contec-Abpm50-Abpm-Bp-Holter-Ambulatory-Blood-Pressure-Monitor-CE-and-FDA.html) was performed using the noninvasive CB-1805-B recorder. Day time was defined as 6:00 am–22:00 pm, BP recordings were taken every 20 minutes, and night time was defined as 22:00 pm–6:00 am, BP recordings were taken every 30 minutes. According to the formula of the percentage of nocturnal BP fall, 100 × [1–(average night SBP/average day SBP)], patients were defined as dippers if their nocturnal BP fall was equal or greater than 10%, overdippers if greater than 20%, and nondippers if 0%–10%. The reverse dippers were regarded less than 0%. As supplementary, this research had found no overdippers and reverse dippers.

Echocardiographic measurements were performed in the left lying position, using GE vivid E95 ultrasound with a 2.0–4.0 MHz transducer (Figure 1). Left atrial diameter (LA), interventricular septum diameter (IVSD), left ventricular end diastolic diameter (EDD), and posterior wall thickness in diastole (PWTD) were acquired according to the standard operation of the echocardiography. LVMI was calculated through the formula of Devereux.

The SPSS 21 was applied for all statistical calculation. Continuous variables were defined as mean ± standard deviation (SD) and were compared by analysis of variance. Normal distribution was assessed through the Shapiro–Wilks test. The categorical variables between two groups were obtained through the χ² test and were showed as percentages. Statistical significance was defined as p < 0.05.

2. Results

Our results were adjusted for major potential confounders, including disease history and sex, as an integral part of the analysis. Dipper, nondipper, and normotensive show no significant difference (p > 0.05) in ages, sex, FBG, high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C). Dipper and nondipper were significantly higher than the normotensive in percentage of the family history of hypertension, BMI, and cholesterol. Furthermore, the nondipper group has significantly higher TG than both dipper and normotensive groups (p < 0.05) (Table 1).

Average 24 h blood pressure in different types of SBP and DSB of both dipper and nondipper groups is higher than in the normotensive group. Coefficient variation of 24 h SBP of nondipper is higher than normotensive (Table 2).

LVMI was higher in high-normal blood pressure patients compared with the normotensive (nondipper was 121 ± 11 g/m², dipper was 108 ± 13 g/m², and normotensive was 98 ± 17 g/m²); furthermore, nondipper was significantly higher than dipper (p < 0.05).

Pearson’s correlation coefficients for the association between LVMI and SBP, DSB, circadian rhythm of blood pressure, age, BMI, TG, TC, HDL-C, LDL-C, coefficient variation of 24 h SBP, and coefficient variation of 24 h DBP are given in Table 3.

3. Discussion

According to the research of Framingham heart study, higher BP will increase the risk of cardiovascular disease, and it was reported that malignant circadian rhythm of blood pressure has a close relationship with the damage of cardiovascular because it was meaningful to judge the damage and prognosis of target organ induced by high-normal blood pressure [6].

Although there are many research studies in the risk factors of hypertension in patients with higher LVMI and left ventricular hypertrophy, studies on the relationship between high-normal blood pressure and LVMI are limited. Previous studies [7, 8] reported that the major type of left ventricular hypertrophy is more popular in nondippers through investigation in patients with treated hypertension, and one study indicated that LVMI is higher in high-normal blood pressure than normotensive [9]. Ekrem et al. reported that patients with prehypertension belonging to nondippers have more impaired LV diastolic function than patients with prehypertension of dipper [10]. Maybe this is due to the fact that only subjects who had a clinical indication to perform ABPM were enrolled in the study. Furthermore, prehypertension includes BP values of 120–139/80–89 mmHg, whereas high-normal BP includes BP values of 130–139/85–89 mmHg. In addition, high-normal blood pressure is probably associated with detrimental alterations of the left ventricle. Cuspidi showed that persistent high-normal blood pressure was correlated with a higher risk of concentric remodeling, left ventricle hypertrophy, and a poor diastolic function [11, 12]. Similarly, after adjustment for various confounding factors, our results demonstrated that LVMI is
higher in high-normal blood pressure than normotensive, and LVMI is increased in the nondipper group compared to the dipper group. To the high-normal blood pressure patients, recent studies recommended that it is more efficient and reliable to monitor their blood pressure through ABPM [13, 14].

### Table 1: Baseline characteristics of the study population.

|                | Dipper (n = 87) | Nondipper (n = 59) | P       | Normotensive (n = 35) | P1   | P2   |
|----------------|-----------------|--------------------|---------|----------------------|------|------|
| Age (years)    | 30 ± 6          | 31 ± 6             | >0.05   | 31 ± 6               | >0.05| >0.05|
| Family history | 26              | 30                 | >0.05   | 12                   | >0.05| >0.05|
| BMI (kg/m²)    | 22.6 ± 2.8      | 22.6 ± 2.9         | >0.05   | 20.9 ± 2.3           | >0.05| >0.05|
| FBG (mmol/L)   | 0.90 ± 0.42     | 4.83 ± 0.83        | >0.05   | 4.8 ± 0.29           | >0.05| >0.05|
| TG (mmol/L)    | 1.0 ± 0.3       | 1.5 ± 0.8          | >0.05   | 0.9 ± 0.4            | >0.05| >0.05|
| TC (mmol/L)    | 4.5 ± 0.7       | 4.4 ± 0.6          | >0.05   | 4.0 ± 0.6            | >0.05| >0.05|
| HDL-C (mmol/L) | 1.3 ± 0.3       | 1.1 ± 0.3          | <0.05   | 1.3 ± 0.3            | <0.05| <0.05|
| LDL-C (mmol/L) | 3.0 ± 0.7       | 2.7 ± 0.6          | <0.05   | 2.1 ± 0.6            | <0.05| <0.05|

*P1 represents the p value of normotensive and dipper; P2 represents the p value of normotensive and nondipper. It is easier to find HDL-C and LDL-C have *p < 0.05 which is considered as statistically significant.*

### Table 2: ABPM findings of high-normal and normotensive patients provided separately for dippers and nondippers.

|                | Dipper (n = 87) | Nondipper (n = 59) | P       | Normotensive (n = 35) | P1   | P2   |
|----------------|-----------------|--------------------|---------|----------------------|------|------|
| 24h SBP (mmHg)| 116.2 ± 10.6    | 118.8 ± 8.6        | <0.05   | 101.2 ± 10.3         | <0.05| <0.05|
| 24h DBP (mmHg)| 76.9 ± 7.3      | 77.8 ± 6.4         | <0.05   | 66.2 ± 6.6           | <0.05| <0.05|
| DSBP (mmHg)   | 122.4 ± 11.0    | 120.3 ± 8.9        | <0.05   | 103.4 ± 9.6          | <0.05| <0.05|
| DDBP (mmHg)   | 81.1 ± 7.4      | 80.2 ± 6.6         | <0.05   | 70.4 ± 7.0           | <0.05| <0.05|
| NSBP (mmHg)   | 106.2 ± 10.6    | 113.4 ± 8.2        | <0.05   | 99.2 ± 7.4           | <0.05| <0.05|
| NDBP (mmHg)   | 67.8 ± 7.4      | 73.7 ± 6.7         | <0.05   | 65.9 ± 5.1           | <0.05| <0.05|
| 24h SBP CV (%)| 10.7 ± 1.9      | 8.7 ± 1.5          | >0.05   | 7.0 ± 1.0            | >0.05| >0.05|
| 24h DBP CV (%)| 13.7 ± 2.6      | 11.4 ± 3.1         | >0.05   | 8.0 ± 1.2            | >0.05| >0.05|

*P1 represents the p value of normotensive and dipper; P2 represents the p value of normotensive and nondipper. 24h SBP, 24h DBP, DSBP, DDBP, NSBP, and NDBP, *p < 0.05 is considered significant.*

![Echocardiographic analysis of left ventricular mass.](image)
and higher BPV are found in the high-normal blood pressure group, and some indicators are even more similar to hypertensive level. Those changes would be reasons that induce the target organ damage, increase the LVMI, and lead the left ventricular hypertrophy. So, it is meaningful to test the high-normal blood pressure group through ABPM and apply intervention treatment that could decrease the target organs damage and prevent hypertension.

4. Conclusion

After multiple relevant clinical confounding factors were adjusted, patients with dipper and nondipper high-normal blood pressure had higher LVMI. Abnormalities in circadian blood pressure variability may be associated with the left ventricular hypertrophy.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Disclosure

Fan-kai Xiao and Ping Li are the co-first authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This work was supported by the Youth Foundation of Henan Scientific Committee (202300410416) and Henan Province Medical Science, Technology Breakthrough Plan Project (LHGJ20190033), Henan Breakthrough Project (212102310797), and Henan Hypertension Manage Project (2018020537).

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| Table 3: Correlation coefficient for the association between LVMI and other facts. |
| r       | t/P  |
| SBP     | 0.511 | 5.761/0.036 |
| DBP     | 0.569 | 5.994/0.034 |
| Patterns | 0.726 | 7.761/0.028 |
| Age     | 0.372 | 4.556/0.030 |
| BMI     | 0.428 | 5.426/0.023 |
| TG      | 0.589 | 4.761/0.017 |
| TC      | 0.489 | 5.225/0.009 |
| HDL-C   | −0.452 | 6.437/0.010 |
| LDL-C   | 0.533 | 4.263/0.021 |
| 24h SBP CV | 0.736 | 6.017/0.010 |
| 24h DBP CV | 0.699 | 5.343/0.008 |
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