Journal of Cardiovascular Disease Research

ISSN: 0975-3583,0976-2833 VOL 9, ISSUE 4, 2018

Elucidation of the characteristics of Ambulatory Blood Pressure Monitoring (ABPM) in hypertensive diabetic individuals

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Abstract

Background: Ambulatory blood pressure monitoring (ABPM) has emerged as an essential tool in managing hypertension among individuals with diabetes, offering advantages beyond traditional office-based blood pressure (BP) readings. Unlike clinic measurements, ABPM provides a more consistent and comprehensive view of BP fluctuations throughout the day and night, offering stronger predictive value for cardiovascular and renal outcomes.

Objective: The present study sought to elucidate the characteristics or patterns of Ambulatory Blood Pressure Monitoring (ABPM) in hypertensive diabetes individuals.

Material and method: The study was conducted in West Bengal. Data was analyzed from 70 randomly selected cases of type 2 diabetes mellitus with hypertension who were admitted. Diabetes and hypertension were observed with 24 hours ambulatory blood pressure changes and the data was evaluated.

Result: Average time of high blood pressure was 6.2 ± 2.7 years. The average length of time with diabetes was 6.5 ±2.7 years. Blood pressure dipping was seen in the following patterns: 45.70% of patients were non-dippers, 37.14% were normal dippers, 12.80% were reverse dippers, and 4.28% were extreme dippers. The types of hypertensions were noted among the 70 individuals with type 2 diabetes and hypertension: White coat hypertension (WHT) was 11.40%, Persistent Hypertension (PHT) was 34.2%, Masked Hypertension (MHT) was 30%, and Controlled Hypertension (CHT) was 24.20%.

Conclusion: We draw the conclusion that patients with diabetes had an exceptionally high prevalence of ABPM changes. Excess blood pressure associated with the cardiovascular risk of diabetes may be connected to abnormalities in the circadian blood pressure pattern and the nighttime systolic blood pressure.

ISSN: 0975-3583,0976-2833 VOL 9, ISSUE 4, 2018

Keywords: Ambulatory blood pressure monitoring, Hypertension, Diabetes, circadian blood pressure and Blood pressure dipping.

1. INTRODUCTION

In India, cardiovascular disease (CVD) is the leading cause of death, accounting for over 2 million deaths and more than a quarter of all deaths in 2015[1]. The fact that India's age-standardized CVD death rate is greater than the global average[2] suggests that steps may and must be made to reduce the growing CVD burden in the future. High blood pressure (BP) is the greatest CVD risk factor globally, accounting for 13% of all fatalities[3] and contributing significantly to the loss of disability-adjusted life years[4]. Improving hypertension control rates should surely result in a reduction in CVD morbidity and mortality. Certainly, considering that an estimated one-third of all persons have hypertension in low- and middle-income nations[5]. The ideal therapy of hypertension begins with a proper diagnosis. Currently, the diagnosis of hypertension in India is dependent on BP measurement in the clinic with a mercury sphygmomanometer, which is prone to errors and misinterpretation [6].

Ambulatory blood pressure monitoring (ABPM) has emerged as an essential tool in managing hypertension among individuals with diabetes, offering advantages beyond traditional office-based blood pressure (BP) readings. Unlike clinic measurements, ABPM provides a more consistent and comprehensive view of BP fluctuations throughout the day and night, offering stronger predictive value for cardiovascular and renal outcomes. It is particularly effective at identifying BP abnormalities such as nocturnal hypertension, a lack of nighttime BP decline (non-dipping), masked hypertension, and white-coat hypertension—conditions frequently encountered in diabetic patients but often undetected during standard office assessments[7-8].

Research indicates that individuals with diabetes are more likely to experience elevated nighttime BP and non-dipping patterns, both of which are associated with heightened risks of cardiovascular complications, as well as the progression of diabetic nephropathy and retinopathy[9]. Moreover, ABPM outperforms office BP readings in forecasting cardiovascular events and overall mortality in this population, reinforcing its value for risk assessment and personalized treatment planning[10].

ISSN: 0975-3583,0976-2833 VOL 9, ISSUE 4, 2018

Relying solely on office measurements can result in misclassification—either underdiagnosis or overdiagnosis—potentially leading to suboptimal treatment decisions in a substantial number of diabetic patients[10]. Reflecting this, international clinical guidelines now endorse the use of ABPM, particularly for diabetic individuals with borderline office BP or those suspected of having atypical BP profiles [9-10]. Although ABPM may not be readily accessible in all healthcare settings, prioritizing its use for high-risk diabetic patients could lead to improved health outcomes and more targeted therapy strategies[11].

Therefore, the present study sought to elucidate the characteristics or patterns of Ambulatory Blood Pressure Monitoring (ABPM) in hypertensive diabetes individuals.

2. MATERIAL AND METHOD

Sample size: Data was analyzed from 70 randomly selected cases of type 2 diabetes mellitus with hypertension who were admitted in the Department of Medicine, West Bengal. Written informed consent was taken, which allowed use of their data for clinical research purposes. Detailed history was taken and routine investigations were done. A simple questionnaire was completed by each patient at the time of the ABPM, and the questionnaire collected information such as the time the patient went to bed, the time the patient got up, Night-time was defined as actual sleep time using the patient's diary.

Inclusion Criteria: Patients of type 2 diabetes mellitus with hypertension who were admitted in the Department of Medicine, West Bengal.

Exclusion Criteria: Exclusion criteria were established to prevent influences on BP variability. Hypertensive individuals were excluded if they were:

- under 18 or beyond 90 years old; and
- The study excluded women who were pregnant,
- worked at night, had sleep apnea syndrome,
- couldn't tolerate ABPM, and
- had a history of arrhythmias.

ISSN: 0975-3583,0976-2833 VOL 9, ISSUE 4, 2018

Clinical examination: Hypertension was defined as systolic blood pressure (SBP) > 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg recorded in the office or during the day. ABPM(EE) criteria include awake SBP ≥ 135 mmHg and/or DBP ≥ 85 mmHg, overnight SBP ≥ 120 mmHg and/or DBP ≥ 70 mmHg, and average SBP ≥ 130 mmHg and/or DBP ≥80.

HbA1c ≥ 6.5%, fasting plasma glucose ≥ 126 mg/dL, 2-hour plasma glucose ≥ 200 mg/dL, or random plasma glucose ≥ 200. The symptoms of hyperglycemia were utilized to diagnose diabetes mellitus.

Procedure:

ABPM Assessment: all Patients with type 2 diabetes mellitus and hypertension underwent 24-hour ambulatory blood pressure monitoring with Meditech Company's model ABPM-05 . Patients wore an ABP monitor for 24 hours and had blood pressure measurements at 20-minute intervals from 06:00 to 22:00 and 30 minutes from 22:00 to 06:00 hours. ABPM collected 24-hour data on patients' blood pressure variations.

Patterns of Nocturnal Blood Pressure Change Using the following formula, the degree of nocturnal blood pressure change (NBPC) was determined:

Degree of NBPC= 100x ((mean day time systolic pressure)- (mean nocturnal systolic pressure)) (Mean day time systolic pressure).

Patients with NBPC >10% and <20% were categorized as "dippers," "extreme dippers" if they had >20%, "non-dippers" if they had >0%, and "risers" if they had >0%. The Japanese circulation's ABPM rules serve as the basis for cut-off points society on the guidelines for ABPM by the Japanese circulation in addition to an earlier study.

Office BP Measurement: After five minutes of rest, an automatic sphygmomanometer took the patient's blood pressure. Three sitting readings in a row were noted. The mean of these three readings served as the office blood pressure in our study. The following are definitions of Persistent Hypertension (PHN), White Coat Hypertension (WHT), Masked Hypertension (MHT), and Controlled Hypertension (CHT): We used office blood pressure thresholds of ≥140/90 mmHg and 24-hour average blood pressure thresholds of > 130/80 mmHg to classify hypertension. The office blood pressure is ≥140/90 mmHg, and the 24-hour average is less than 130/80 mmHg. MHT is the

ISSN: 0975-3583,0976-2833 VOL 9, ISSUE 4, 2018

24-hour average blood pressure of ≥130/80 mmHg and the office blood pressure of <140/90 mmHg. The office blood pressure of 140/90 mmHg and the 24-hour average of 130/80 mmHg are considered persistent hypertension (PHT). Controlled Hypertension (CHT) office blood pressure <140/90 mmHg and 24-hour mean blood pressure <130/80.

Statistical Analysis: SPSS 22 software was used for analysis after the data was entered into a Microsoft Excel data sheet. Frequencies and proportions were used to represent categorical data. For qualitative data, the Chi-Square Test was employed as the significance test. The mean and standard deviation were used to describe continuous data. For quantitative data, the Analysis of Variance (ANOVA) test was used to determine the significance of the mean difference between more than two groups. P value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

3. RESULTS:

Following data analysis of 70 patients with type 2 diabetes and hypertension, subjects' mean age was 51.5 ± 13.7 years.

		Mean	SD
Age		51.5	13.7
Gender	Female	23	32.90%
	Male	47	67.10%
Duration of HTN		6.2	2.7
Duration of DM		6.5	2.7
FBS		126.7	14.1
PPBS		233.1	24.9
HbA1c		8	0.8
Serum Cholesterol		170.1	34.9
VLDL		38	4
LDL		130	14
HDL		41	2.5
STG		158	15.1
UACR		169.4	93.1

ISSN: 0975-3583,0976-2833 VOL 9, ISSUE 4, 2018

ABPM SBP	137	18.8
ABPM DBP	80.0	14.1

Table 1. Profile of Diabetic Subjects in the Study

The majority, almost 67.1%, were men. Average time of high blood pressure was 6.2 ± 2.7 years. The average length of time with diabetes was 6.5 ±2.7 years. Blood pressure dipping was seen in the following patterns: 45.70% of patients were non-dippers, 37.14% were normal dippers, 12.80% were reverse dippers, and 4.28% were extreme dippers (Table 3). The following types of hypertensions were noted among the 70 individuals with type 2 diabetes and hypertension: White coat hypertension (WHT) was 11.40%, Persistent Hypertension (PHT) was 34.2%, Masked Hypertension (MHT) was 30%, and Controlled Hypertension (CHT) was 24.20%. (Table 2).

		Count	Percentage
Type of HTN	Controlled HTN	17	24.20%
	Masked HTN	21	30.00%
	Persistent HTN	24	34.20%
	White coat HTN	8	11.40%

Table 2. Type of HTN

		Count	Percentage
NBPC	<0 Reverse dippers	9	12.80%
	0 to 9 Non dippers	32	45.70%
	10 to 20 dippers	26	37.14%
	> 20 extreme dippers	3	4.28%

Table 3. Showing Pattern of Diurnal Index in the Study Population

In the study 12.80% were reverse dippers, 45.70% were non dippers, 37.14% were dippers and 4.28% were extreme dippers.

4. DISCUSSION

ISSN: 0975-3583,0976-2833 VOL 9, ISSUE 4, 2018

This investigation found a notably high prevalence of disrupted circadian blood pressure (BP) patterns in individuals with type 2 diabetes mellitus (T2DM) and hypertension. Over 50% of participants demonstrated inadequate daytime BP control, while two-thirds exhibited either nocturnal hypertension or a non-dipping BP pattern. Additionally, 11.40% were identified with the white coat phenomenon. Based on clinic-based BP readings, 45.6% were classified as hypertensive, encompassing both persistent hypertension and white coat hypertension. However, ambulatory blood pressure monitoring (ABPM) reclassified 64.2% as hypertensive, excluding white coat cases and identifying instances of masked hypertension.

Gorostidi et al. observed that the frequency of non-dipping BP patterns was higher in diabetic hypertensive patients (64.2%) than in non-diabetics (51.6%). Furthermore, 33% of diabetic patients were reported to have white coat hypertension, 52% had daytime BP values ≥135/85 mmHg, and two-thirds experienced elevated nighttime BP[8].

Ashok Duggal's study, involving 100 hypertensive T2DM patients, indicated 46% were non-dippers, 45% were normal dippers, while reverse and extreme dippers made up 3% and 6%, respectively[12].

Cuspidi et al. suggested that a single ABPM measurement might provide a more reliable indication of non-dipping status in diabetic compared to non-diabetic patients[13]. According to A. de la Sierra et al., diabetic individuals often present with irregular BP circadian rhythms[14].

Although white coat hypertension (WCH) is typically viewed as lower risk for cardiovascular events, in diabetic patients, WCH contributes to increased cardiovascular risk. Previous studies have reported WCH prevalence among diabetics ranging from 14% to 51%. Eguchi et al. identified a 26% prevalence of WCH in T2DM patients (defined as clinic hypertension with 24-hour BP <135/80 mmHg), also noting a significantly higher incidence of silent cerebral infarctions in these individuals compared to non-diabetics with WCH ($P < 0.05$)[15].

In a long-term study, T2DM patients exhibiting a "riser" BP profile experienced an 88% mortality rate over nine years, in contrast to 45% among non-risers. Kramer et al. documented a 23% prevalence of WCH in T2DM (clinical hypertension with daytime BP <135/85 mmHg), and found

ISSN: 0975-3583,0976-2833 VOL 9, ISSUE 4, 2018

that compared to normotensive patients, those with WCH had more than twice the risk for diabetic retinopathy and nephropathy[10].

Eguchi et al.[15] also explored cardiovascular event rates over four years in sustained and WCH patients, with and without T2DM, reporting a WCH prevalence of approximately 20% in diabetic individuals.

Leitao et al. conducted a study involving 135 T2DM patients and found a 30% prevalence of masked hypertension. The International Database on Ambulatory Blood Pressure in Relation to Cardiovascular Outcome (IDACO) reported a similar masked hypertension prevalence of 29.3%[16].

5. CONCLUSION

Abnormal circadian blood pressure (BP) patterns are common in type 2 diabetes patients with hypertension. Many exhibit non-dipping or reverse-dipping profiles, uncontrolled daytime BP, and nocturnal hypertension. White coat and masked hypertension are also frequent, complicating diagnosis and increasing cardiovascular risks. When combined with diabetes, white coat hypertension is linked to higher rates of cerebral infarcts, nephropathy, and retinopathy. A riser BP profile is associated with significantly increased mortality. These findings highlight the need for routine ambulatory BP monitoring in diabetic patients to detect abnormal patterns early and guide effective management to reduce long-term complications.

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