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Research Article

Ambulatory Blood Pressure Monitoring in Patients with Chronic Kidney Disease: The Need of an Hour

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ABSTRACT

Introduction: Uncontrolled HTN, masked HTN and blood pressure variability play a pivotal role in further decline in kidney function in chronic kidney disease (CKD). Blood pressure variability (BPV), captured by ABPM, reflects autonomic regulation and vascular health and is now described as a predictor of adverse renal and cardiovascular outcomes.

Methodology: We performed a cross-sectional study from October 2018 to September 2019 in a tertiary care centre in western India to evaluate the ABPM patterns in 120 CKD patients. Appropriate-sized cuff of ABPM was applied over nondominant arm. The BP was measured at an interval of 30 minutes over day and night. The ABPM characteristics were analysed in patients with estimated Glomerular filtration rate (eGFR) categories- G3a to G5.

Results: The average age of the patient cohort was 61.96 ± 8.23 years with male being 62.25%. The mean e-GFR of the cohort was 30.61 ± 4.73 mL/min/1.73 m2. Non-dipping during nighttime BP measurement was seen in 46.67, 56.67, 53.33 and 50% patients with G3a, G3b, G4 and G5 categories respectively and reverse dipping was observed in 13.33% each in G3b and G4 group and 26.67% in G5 group. In this cohort of CKD patients, 50% had masked HTN and 10% had white-coat HTN.

Conclusion: ABPM is a useful tool to detect and monitor hypertension. It can detect BPV, masked and nocturnal HTNs which are predictive of unfavourable outcomes in CKD patients. It also helps to optimize antihypertensive therapy by tailoring medication timing and assessing treatment effectiveness.

Keywords*: CKD, ABPM, Hypertension, blood pressure variability, mask hypertension, white coat hypertension, estimated glomerular filtration rate.*

INTRODUCTION

CKD is defined as structural or functional abnormality of kidney, that last for more than 3 months with health impairment (1). It is a complex condition causing irreversible renal dysfunction progressing to end-stage kidney disease (ESKD). It affects approximately 850 million people globally and 13.24% Indian population (1,2). Since there is scarcity of medical facilities, uncontrolled risk factors, and delayed referral to the specialists, there is rapid progression CKD in the Indian population than in developed countries with mean age of the ESRD population in India being 47 years (3).

Patients with CKD have increased risk of adverse cardiac events due to chronically overactivated sympathetic nervous system (SNS), effects of hypertension and BPV on kidney, heart and vasculature that further worsens the progression of kidney dysfunction (4–7). Hypertensive patients are at high risk of ischaemic heart disease, arrhythmias, congestive heart failure (CHF), left ventricular hypertrophy and stroke (6). On the other hand, hypertension is one of the most common complications of CKD, that further impairs renal function and substantially increases the CV risk (7).

Identification of HTN and blood pressure (BP) control is crucial in the treatment of CKD patients regardless of CKD stage and underlying cause (1). Office BP measurement is the most common method used to diagnose and monitor HTN. However, a cross-sectional study of Spanish ambulatory blood pressure monitoring (ABPM) registry including 5693 hypertensive patients with CKD showed that BP control was misclassified in 1 of 3 CKD patients with HTN, that supports utility of ABPM (8).

Ambulatory blood pressure monitoring (ABPM) has become an established clinical tool for the evaluation and management of hypertension both in clinical practice and in the research setting (9). ABPM involves serial BP measurements at specific time intervals throughout a 24-hour period, thereby providing a better assessment of the normal fluctuations in BP levels associated with daily activities and sleep.

ABPM helps not only to detect hypertension burden precisely but also to detect nocturnal hypertension, which is associated with more adverse events than daytime hypertension in patients with CKD (8,10). It also helps differentiate high office BP with normal overall average BP by ABPM (white coat hypertension) or normal office BP but elevated ABPM levels (masked hypertension) and detects variations in BP over 24 h period (BPV) (11–13).

In spite of evidence suggesting that ABPM is better than office BP measurement especially in patients with CKD, the data in Indian patients is limited. We aim to study the ABPM characteristics in advanced CKD patients.

MATERIAL AND METHODS

Study Design and Population

It was a cross-sectional study carried out from October 2018 to September 2019 in a tertiary care centre in Western part of India. Patients diagnosed with chronic kidney disease as per KDIGO definition of CKD satisfying inclusion criteria were grouped based on estimated glomerular filtration rate (eGFR) as G1 to G5 (Table 1) (1). Patients diagnosed with CKD class G3a, G3b, G4 and G5 aged above18 years were included in the study. Patients with CKD class G1 and G2, secondary hypertension other than CKD were excluded. Each Class G3a, G3b, G4 and G5 of CKD had 30 cases each. The eGFR was calculated using Modification of Diet in Renal Disease (MDRD) equation (14).

All included patients underwent detailed evaluation and socio-demographic, detailed clinical data was collected. Data related to laboratory test results and ongoing treatment was collected. These patients were evaluated to rule out other aetiologies of secondary hypertension. ABPM was performed by Hingmed device. Appropriate-sized-cuff was applied to nondominant arm. The BP was measured every 30 min. G3a, G3b and G4 CKD cases were then subjected to ABPM for 1 day (24 hours) while G5 CKD (On dialysis) cases were subjected for ABPM for 2 days (48 hours) day 1-Predialysis and Day 2 (on the day of dialysis). The BP was considered elevated when the mean day BP were above 135/85 mm Hg and mean night BP were above 120/70 mm Hg (15). The ratio of mean night to day BP was used to calculate the Dipping status. Normally, BP dips about 10% -20% during night. We classified patients as extreme dippers, dippers, non-dippers, reverse dippers (based on ratio of mean night to day BP) when the ratio was < 0.80, 0.80 - 0.90, 0.90 - 1.00, and >1.00 respectively.

Statistical Analysis

The data was analysed using the SPSS vs 25.0. Quantitative data was described as mean and standard deviation (SD) and compared using *t*-test. Qualitative data was described as number and percentages and compared using Chi-square test. The p-value of < 0.05 was considered as significant.

RESULTS

Baseline characteristics: The 120 patients with CKD were grouped into four groups based on eGFR as per KDIGO classification and each group had 30 patients. The average age of the patient cohort was 61.96 ± 8.23 years with male preponderance (62.25%). The mean e-GFR of the cohort was 30.61 ± 4.73 mL/min/1.73 m^2. Of the 120 patients 60%, 42.5% and 14.17% were hypertensive, diabetic and obese respectively. Patients' demography and comorbidity as per their category of CKD is depicted in Table 2.

ABPM Characteristics: The ABPM unhides some special characteristics of HTN in CKD. The result of ABPM is depicted in Table 3. As the CKD progresses and e-GFR declines the mean 24-hour, daytime, and night time systolic BP increased. However, mean 24-hour BP, daytime BP, and night time diastolic BP decreased as eGFR decreased. CKD patients were found at risk of non-dipping HTN. In this cohort of CKD patients there was no physiologic dipping of BP during night in 46.67, 56.67, 53.33 and 50% patients with G3a, G3b, G4 and G5 categories respectively and as the eGFR declines further there was reverse dipping (13.33% in G3b and G4 respectively Vs 26.67% in G5). In this cohort, 50% patients with CKD had masked HTN and 10% had white-coat HTN.

Table 1. KDIGO 2024 classification of CKD based on eGFR (CKD: Chronic kidney disease; e-GFR: estimated glomerular filtration rate)

GFR Categories		e-GFR (ml/min/1.73 m2)
G1	Normal or high	≥ 90
G2	Mildly decreased	60 – 89
G3a	Mildly to moderately decreased	45 – 59
G3b	Moderately to severely decreased	30 – 44
G4	Severely decreased	15 – 29
G5	Kidney failure	≤ 15

Table 2. Demographic and hypertension characteristics among the study subjects. Quantitative data described as mean ± SD and qualitative data described as number and percentages (CKD: Chronic kidney disease; e-GFR: estimated glomerular filtration rate)

Baseline characteristics	All CKD patients (n = 120)	G3a (n = 30)	G3b (n = 30)	G4 (n = 30)	G5 (n = 30)	P value
Mean age ± SD (years)	61.96 ± 8.23	62.34 ± 9.21	59.17 ± 5.82	65.78 ± 4.91	60.54 ± 7.13	0.02
Sex, Male (%)	75 (62.5)	17 (56.67)	19 (63.33)	17 (56.67)	20 (66.67)	0.03
Mean e-GFR ± SD (mL/min/1.73 m^2)	30.61 ± 4.73	51.78 ± 3.64	38.65 ± 4.41	21.83 ± 4.89	10.17 ± 5.2	0.008
Hypertension (%)	72 (60)	16 (53.33)	18 (60)	17 (56.67)	21 (70)	0.3
Diabetes (%)	51 (42.5)	17 (56.7)	11 (36.7)	9 (30)	14 (46.7)	0.04
Obesity (%)	17 (14.17)	4 (13.3)	5 (16.67)	3 (10)	5 (6)	0.03

Table 3. The result of ambulatory blood pressure measurement in the four groups. Quantitative data described as mean ± SD and qualitative data described as number and percentages. (ABPM: Ambulatory blood pressure monitoring; DBP: Diastolic blood pressure, SBP: Systolic blood pressure).

ABPM Characteristics		All CKD patients	G3a (n = 30)	G3b (n = 30)	G4 (n = 30)	G5 (n = 30)	P value
24 Hour ABP (mean ± SD)	SBP	132.93 ± 10.62	130.1 ± 11.4	131.74 ± 10.48	133.2 ± 10.3	136.7 ± 10.3	0.006
	DBP	73.12 ± 7.49	75.01 ± 7.6	74.39 ± 6.81	72.78 ± 7.86	70.32 ± 7.7	0.008
Daytime ABP (mean ± SD)	SBP	135.5 ± 10.45	132.90 ± 11.20	135.3 ± 8.41	135.70 ± 11.30	138.10 ± 10.90	0.003
	DBP	74.77 ± 7.4	76.60 ± 7.80	76.2 ± 7.18	74.10 ± 7.60	72.20 ± 7.10	0.03
Nighttime ABP (mean ± SD)	SBP	126.93 ± 11	122.50 ± 12.10	124.91 ± 9.83	128.10 ± 11.07	132.20 ± 10.99	0.009
	DBP	66.18 ± 7.8	67.70 ± 7.70	68.52 ± 8.37	65.40 ± 7.65	63.12 ± 7.61	0.007
Blood pressure variability, n (%)	Extreme dippers	4 (3.33)	1 (3.33)	0 (0)	1 (3.33)	2 (6.67)	0.1
	Dippers	37 (30.83)	13 (43.33)	8 (26.67)	9 (30)	7 (23.33)	0.02
	Non-Dippers	62 (51.67)	14 (46.67)	17 (56.67)	16 (53.33)	15 (50)	0.024
	Reverse Dippers	18 (15)	2 (6.67)	4 (13.33)	4 (13.33)	8 (26.67)	0.005
Masked Hypertension, n (%)		40 (30)	12 (40)	13 (43.33)	15 (50)	20 (66.67)	0.008
White coat HTN, n (%)		17 (14.17)	2 (6.67)	3 (10)	5 (16.67)	7 (23.33)	0.006

Table 4. Comparison of our study with various studies. Quantitative data described as mean ± SD and qualitative data described as number and percentages. (ABPM: Ambulatory blood pressure monitoring; DBP: Diastolic blood pressure, SBP: Systolic blood pressure). [# 48 hours mean (mmHg)]

ABPM Characteristics		Our study	Mojón et al (17)	Borrelli et al (18)	Asserraji et al (23)	Bangash and Agarwal (21)	Tang et al (22)
24 Hour ABP (mean ± SD)	SBP	132.93 ± 10.62	131.5±16.2[#]	127 ± 16	147.28±12.65	-	-
	DBP	73.12 ± 7.49	74.8±11.6[#]	73 ± 10	74.44±5.86	-	-

Daytime ABP (mean ± SD)	SBP	135.5 ± 10.45	134.7±16.5	130 ± 17	-	-	-
	DBP	74.77 ± 7.4	77.9±12.3	75 ± 11	-	-	-
Nighttime ABP (mean ± SD)	SBP	126.93 ± 11	125.0±17.9	121 ± 19	-	-	-
	DBP	66.18 ± 7.8	68.7±11.3	67 ± 11	-	-	--
Blood pressure variability, n (%)	Extreme dippers	4 (3.33)	-	-	-	-	-
	Dippers	37 (30.83)	-	-	-	-	-
	Non-Dippers	62 (51.67)	60.6%	66.0%	-	-	-
	Reverse Dippers	18 (15)	-	-	-	-	-
Masked Hypertension, n (%)		40 (30)	-	-	-	8.3%	16.11%
White coat HTN, n (%)		17 (14.17)	-	-	-	18.3%	10.21%

DISCUSSION

Accurate BP measurement is important for appropriate diagnosis and correct management of HTN. This is applicable to CKD patients too who commonly have HTN. Since, there is a close relationship between CKD with hypertension and poor cardiovascular outcomes, treatment of hypertension is of utmost necessary in CKD patients [6]. ABPM is a tool that helps to measure BP over 24 hours and it is being used since the 1980s. The BP is recorded continuously, at an interval of 30 minutes, the BP values vary throughout the day, with values increase in day time and falls while in sleep. It has been reported in some studies that this circadian rhythm is disturbed in patients with CKD (16).

In our study, the analysis of ABPM parameters revealed average 24-hour, daytime and nighttime SBP increased with advancing CKD stage and CKD G5 had highest values of SBP. On the contrary, average 24-hour, daytime and nighttime DBP deceased with advancing CKD stage. There was deranged diurnal variation in the blood pressure with loss of physiologic dipping during nighttime BP and reverse dipping as the CKD progressed. The results of our study are similar to the results described in a study by Mojón et al and Borreliu et al where prevalence of non-dipping was 60.6% and 66%, higher in patients with CKD (Table 4) (17,18). A meta-analysis by Mehmet Kanbay et al found CKD progression is directly proportional to non-dipping blood pressure status (19). An impaired diurnal variation in BP is associated with a progression of CKD, proteinuria, cardiovascular diseases and all-cause mortality (20).

The prevalence of masked HTN was 8.3 and 16.11% in studies by Bangash and Agarwal and Tang et al respectively which is much lower than that of ours (Table 4). Whereas, the prevalence of white coat hypertension was 18.3% and 10.21% in these studies (21,22). Progression to ESRD in CKD patients with white-coat HTN is slower as compared to masked hypertension. Thus, estimating the prevalence of masked and white-coat HTN is of epidemiologic as well as of clinical importance. In our study, 30 % of the CKD patients showed masked HTN and 14.14% had white coat HTN.

CONCLUSIONS

HTN and CKD go hand in hand. Hypertensive are at risk of developing CKD and CKD patients are likely to have hypertension. Both HTN and CKD are at risk of developing CVD. Appropriate diagnosis of HTN, identifying the true status of BP control is necessary for optimal treatment of HTN in CKD patients. ABPM can detect masked HTN and nocturnal HTN and BPV which predict end organ damage and progression of CKD. Isn't ABPM a need of an hour in CKD?

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