RESEARCH ARTICLE

Role of ambulatory blood pressure monitoring in management of hypertension in patients with chronic kidney disease on hemodialysis

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Vajed M, Atul S, Tushar D, et al. Role of ambulatory blood pressure monitoring in management of hypertension in patients with chronic kidney disease on hemodialysis. J Kidney Treat Diagn 2021;4(3):0-1.

Background: Chronic kidney disease (CKD) is strongly associated with hypertension (HTN) and each can cause or aggravate the other. Ambulatory blood pressure monitoring (ABPM) is a superior prognostic marker compared with office BP and has successfully identified hypertensive CKD patients at increased risk. ABPM provides information on circadian BP variation and short-term BP variability, which is associated with cardiovascular and renal outcomes. This review examines the role of ambulatory blood pressure monitoring in management of hypertension in patients with chronic kidney disease undergoing regular hemodialysis.

Aims and objectives: To study the role of ambulatory blood pressure monitoring in management of hypertension in patients with chronic kidney disease undergoing regular hemodialysis and to study the correlation between intradialytic blood pressure with ambulatory blood pressure monitoring.

Methods: This was an observational study of CKD patients undergoing hemodialysis with Hemodialysis vintage more than 1 month who performed ABPM in tertiary care unit. Data collected from clinical record and ABPM records.

Results: A total of 100 hypertensive CKD patients were reviewed. The correlation between intradialytic blood pressure with ambulatory blood pressure was found to be statistically significant. Pre-HD SBP correlated with 24 hour mean SBP, active period SBP and passive period SBP.

Conclusion: There was a statistically significant correlation between intradialytic blood pressure and ambulatory blood pressure. Interdialytic weight gain and cholesterol are modifiable risk factors. Pre-HD SBP and 24 hour mean SBP were independent risk factor for IDH. Patients with higher BP have higher BP burden (intradialytic and interdialytic) and may require aggressive control of BP.

Key Words: *Chronic kidney disease; Hypertension; Ambulatory blood pressure monitoring*

INTRODUCTION

Chronic Kidney Disease (CKD) is a condition in which there is heterogenous disorders affecting kidney function and structures that encompasses degree of decreased renal functions. Chronic kidney disease (CKD) and hypertension are intertwined inextricably: 70% of individuals from general population with elevated serum creatinine are hypertensive1, and a cause and a consequence of CKD is hypertension [1]. ABPM pattern in CKD patients showed showing an altered circadian rhythm and an increased rate of reverse dipping and non-dipping. As stage of CKD progresses the prevalence of reverse-dippers and non-dippers increases progressively. ABPM is particularly useful for CKD progression, predicting CV risks and end stage renal disease (ESRD). Ambulatory blood pressure monitoring (ABPM) has been shown to be a more accurate technique than CBP to diagnose hypertension and to stratify cardiovascular risk, especially in patients with CKD stages 3-5 [2, 3, 4]. Ambulatory blood pressure monitoring (ABPM) is particularly useful management of hypertension both in the research setting and in clinical practice. In this regard, ABPM has been shown to a better tool in evaluating the patient with highly variable BP. ABPM minimizes the effect of anxiety-induced BP elevations known as White Coat Hypertension (WCH) as BP is monitored over a longer period in the child's own environment [5, 6]. For diagnosis of masked hypertension, ABPM is better tool as compared to CBP where an office setting is normal, however BP is found to be high at other times during 24 hours [5]. ABPM gives prognostic value for predicting CV outcomes and CKD progression.

AIMS AND OBJECTIVES

• To study the role of ambulatory blood pressure monitoring in management of hypertension in patients with chronic kidney disease undergoing regular hemodialysis.

• To study the correlation between intradialytic blood pressure with ambulatory blood pressure monitoring.

• To compare the hypertensive status as determined by ambulatory blood pressure monitoring versus hypertensive status determined by pre-dialysis blood pressures.

• To determine whether Ambulatory Blood Pressure Monitoring can predict intradialytic hypertension.

MATERIALS AND METHODS

• Place of Study: Tertiary care centre in western region of Maharashtra state, India.

• Period of Study: January 2020-December 2020.

• Sample Size: 100 cases.

Exclusion criteria

This was an observational study of CKD patients undergoing hemodialysis with ambulatory blood pressure monitoring.

Ambulatory Blood Pressure Monitoring (ABPM)

• After a mid-week hemodialysis treatment subject was asked to wear ABP monitor on next day morning on the non-access arm.

• The ABP monitor was turned on and the subject was advised to wear cuff and monitor for 24 hour.

• B.P. was recorded half hourly (30 min) from 10 a.m.-10 p.m. and one hourly (60 mins) from 10 p.m.-10 a.m.

• Subjects were advised to continue their diet and hypertensive drugs during the study period.

• In case if cuff had switched off or had improper readings then repeated monitoring was done.

• At least 70% of BP values needed to be satisfactory; otherwise, ABPM was to be repeated.

• Average 24h-, day time-, and night time-BPs were calculated as well as the dipping status were used in the further management of hypertension. Subjects define as dippers when night time BP decreases to >10% compared to day time BP equivalent to night BP/day BP 0.9%. The rise in blood pressure in early morning time which provides additional prognosis information is termed as morning surge. Intradialytic Hypertension (IDH)7 was defined as rise in SBP during the hemodialysis session more than or equal to 10 mm of Hg from pre dialysis blood pressure from two out of three consecutive H.D. sessions. Hypertension 8 was defined as per KDIGO 2012: Systolic blood pressure>140 and diastolic blood pressure >90 mm of Hg.

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Statistical analysis

• Continuous variables were described as mean ± Standard deviation (SD) or median ± interquartile.

• Pearson correlation coefficient was used to determine correlation between pre-dialysis blood pressure, post-dialysis blood pressure, mean day time blood pressure, mean nocturnal blood pressure and 24-hour average blood pressure.

• Cohen's Kappa agreement was done to determine agreement between ambulatory blood pressure monitoring and pre-dialysis blood pressure to define hypertension.

• Univariate and multivariate regression analysis was done to assess the relationship between intradialytic hypertension and factors like pre-HD SBP, gender, diabetes mellitus, HD vintage, interdialytic weight gain, frequency of HD, and type of anti-hypertensive drugs.

• Kaplan Meier survival analysis was done to compare the survival in IDH and non IDH groups (Figure 7).

• The data were analyzed with appropriate statistical method viz. Chi Square test, Fisher's exact test, and paired test with the help of IBM-SPSS version 20.0.

• Paired test was used for the parametric variables with p value of <0.05 considered as statistically significant.

• Fisher's exact test was used for contingency tables.

DISCUSSION

This study was conducted in a tertiary care referral Centre. The study was undertaken to determine the role of Ambulatory Blood Pressure Monitoring in management of Hypertension in patients with chronic kidney disease undergoing regular hemodialysis and to assess correlation between intradialytic blood pressure with ambulatory blood pressure monitoring. Total 100 patients diagnosed as chronic kidney disease stage V on maintenance hemodialysis with HD vintage more than one month were studied. 31 (31%) patients were found to have Intradialytic hypertension (IDH). This difference in prevalence was probably because of poor compliance of patients for anti-hypertensive drugs, twice a week HD in some patients and smaller sample size [9]. States that 21.3% subjects had IDH in hemodialysis treatments of 22955 patients [10]. States that IDH was found in 18% out of 531 subjects [11]. The IDH occurrence in previous studies by Mess was found to be between 5%-15% [12-14]. 75(75%) were males and 25(25%) were females, mean age of all subjects (n=100) was 42.26 ± 14.69 years with minimum 18 years and maximum 72 years. A study by Peter net al15.had mean age of 54.5 years with predominantly males (80%). In our study, 95(95%) had history of hypertension, 28(28%) had history of diabetes mellitus, and 12(12%) had history of ischemic heart disease. A cohort study by Munter from 2010 states that hypertension was found in 86% of CKD patients [15]. A study by Grekas states that hypertension was found in 65%-85% of hemodialysis patients [16]. Out of all subjects, 44 (46%) were diagnosed as chronic glomerular disease, 20 (20%) had chronic tubule-interstitial disease, 28(28%) had diabetic nephropathy, 3(3%) had autosomal dominant polycystic kidney disease and 3(3%) had obstructive uropathy as causes of CKD. In IDH group (n=31), 12(39%) subjects were on maintenance hemodialysis for less than 6 months and 31(61%) for more than 12 months, whereas 38(55%) subjects were on maintenance hemodialysis for less than 6 months and 31(45%) for more than 12 months in non-IDH group (n=69). To assess the relation between HD vintage and intradialytic hypertension (IDH), we compared these parameters in both groups. It was found that prevalence of IDH was higher in patients with more HD Vintage which was statistically significant. (P=0.001) It will be important to investigate the role of dialysis related inflammation and vascular changes in IDH. In none of the previous studies, HD vintage was taken into consideration. In IDH group (n=31), non-tunneled un-cuffed catheter was used in 3 (10%), tunneled cuffed catheter in 14(45%) and A V Fistula in 14 (45%) subjects as hemodialysis access. In non-IDH group (n=69), non-tunneled un-cuffed catheter was used in 10 (14%), tunneled cuffed catheter in 67(54%) and A V Fistula in 22(32%) subjects for hemodialysis access. Patients who are on less frequent hemodialysis have more interdialytic weight gain and are more prone for intradialytic hypertension. Our study showed slightly greater percentage of IDH in patients with twice a week HD than in patients taking thrice a week HD. However, it did not reach statistical significance (p-0.25). As fluid status plays an important role in hypertension in patients on hemodialysis, we compared the IDW in both IDH and non-IDH groups. This factor has probably not been emphasized previously as an association with IDH. However, in our study IDW was significantly higher in IDH group (p-0.004). This emphasizes the role of fluid volume in hypertension in IDH patients. When we compared the target dry weight in both groups, it showed no statistically significant difference (p-0.98). The IDH was probably related to the incremental change in fluid volume status in interdialytic period than absolute dry weight. 96(96%) subjects were on calcium channel blockers, 70(70%) were on beta blockers, and 44(44%) were on alpha blockers. A study by Sica found that requirement of anti-hypertensives was more in IDH group, and specifically of CCBs [17]. In ABPM monitoring, 86% showed dipping pattern and 14% showed non-dipping pattern. A study by Catia found that 50% of patients presented with a non-dipper pattern of BP [18]. A cross-sectional study by Mojon involving 10271 hypertensive patients, enrolled in the Hygia project, of which 3227 had CKD, showed a non-dipper was found in 61% patients with hypertension [19]. Non-dipper proportion increased as stages of CKD worsened. Farmer showed 53% occurrence of CKD patients had a non-dipper status [20]. In our study, 9 (9%) subjects died within 6 months of starting study period and 91 (91%) subjects survived for more than 6 months. Out of 9 deaths, 3 patients had Intradialytic hypertension (IDH) and 6 patients were in the non-IDH groups (Table 1).

TABLE 1

Demographic details and baseline characteristics all subjects

Parameters	Group1(n=69) (without IDH)	Group 2(n=31) (with IDH)	P Value	S / NS
Age, Year	42.90 (±14.15)	40.84 (±15.99)	0.52	NS
Males %	49 (71%)	26 (84%)	0.17	NS
D.M.	18 (26%)	18 (58%)	0.005	S
HTN %	65 (94%)	30 (97%)	0.58	NS
IHD %	09 (13%)	3 (10%)	0.63	NS
HD vintage	9.75 (±8.87)	15.19 (±16.96)	0.001	S
ACCESS				
AVFistula%	22 (32%)	14 (45%)	0.42	NS
Perm Cath%	67 (54%)	14 (45%)		
TempCath%	10 (14%)	3 (10%)		
Frequency of HD per week				
Twice	44 (64%)	16 (51%)	0.25	NS
Thrice	25 (36%)	15 (49%)		
TDW	52.26 (±10.94)	52.22 (±11.17)	0.98	NS
IDWG	1.65 (± 0.73)	2.14 (±0.83)	0.004	S
CCB(n=96)	65 (94.20%)	31 (100%)	0.17	NS
α –blocker (n=44)	22 (31.88%)	22 (70.90%)	< 0.001	S
β –blocker (n=70)	43 (62.3%)	27 (87%)	0.01	S
CS (n=14)	4 (5%)	10 (32.25%)	0.03	NS
Serum Cholesterol level	188.3 (±32.62)	205.7 (±35.7)	0.001	S
Dipping Pattern	Child with CKD	Child with CKD	Child with CKD	Child with CKD
Dipper	8 (57.14)	6 (42.86)	0.30	NS
Non- Dipper	61 (70.9)	25 (29.1)		
Outcome				
Survival	64 (70.39)	27 (29.67)	0.36	NS
Death	5 (55.50)	4 (44.45)		

The group of non IDH patients had more survival rate as compared to the group of IDH patients. Although, this did not reach statistical significance. This survival benefit needs to confirmed with larger sample size and longer follow-up duration. No statistically significant difference was found in both groups. (Fisher exact test: p=1). The correlation between intradialytic blood pressure with ambulatory blood pressure was found to be statistically significant. Pre-hemodialysis Systolic blood pressure correlated with 24 hours mean SBP, active period SBP and passive period SBP (p-value<0.0001) A study by Peter demonstrated that systolic ABP significantly correlated with pre-HD systolic BP (r=0.65, P <0.0001) [21]. A previous study by Mendes found that pre-HD SBP correlates with ABP [22]. When Pre-hemodialysis Diastolic blood pressure was compared with 24 hours mean DBP, active period DBP and passive period DBP, it showed significant correlation with p-value of <0.0001 (Table 2). Association between HTN as pre-HD blood pressure and HTN as ambulatory blood pressure showed poor agreement (Cohen Kappa agreement K=0.2229). A recent meta-analysis by in rig also

found that pre-HD blood pressure and ABP showed poor agreement [23] (Table 3). Association between HTN as ABPM and intradialytic hypertension (IDH) showed statistically significant correlation (p=0.005) (Table 4). There was 85% probability of non-having IDH if there was no hypertension in ABPM. (Negative predictive value=0.85) In IDH group of patients (n=31), 24 hour mean SBP, Active period SBP, Passive period SBP was significantly higher compared to non IDH group of patients (n=69) (p-value of<0.0001, <0.0001, 0.01 respectively) (Figures 1, 2). A study by Peter et al21. Showed the average 44-hr ambulatory systolic BP was significantly higher (155.4 vs 142.4 mm Hg) in patients with intradialytic hypertension. Similarly, 24 hours mean DBP, Active period DBP, Passive period DBP in IDH group (n=31) was significantly higher than non-IDH group (n=69). (p-value of 0.01,0.01,0.05 respectively). A study by Peter showed the average 44-hr ambulatory diastolic BP was non-significant (p-value 0.80, 0.51, 0.20) in patients with intradialytic hypertension. Studies by Inrig and Inrig JK showed association of intradialytic HTN with increased morbidity and mortality [23,24]. A study by Chi-Young Choi found that the overall survival rate was more in non IDH group of patients than IDH group of patients [25]. Regression analysis was performed to find out independent risk factors for IDH. 24 Hour mean SBP was also found to be an independent risk factor (p-0.000) for IDH after adjusting for gender, diabetes mellitus, HD vintage, cholesterol, IDWG, frequency of HD and types of anti-hypertensive drugs (CCB, α blocker, β blocker, CS). The correlation between intradialytic blood pressure with ambulatory blood pressure was found to be statistically significant. Pre-hemodialysis Systolic blood pressure correlated with 24 hour mean SBP, active period SBP and passive period SBP (Figures 3, 4) .When Pre-hemodialysis Diastolic blood pressure compared with 24 hour mean DBP, active period DBP and passive period DBP, it showed significant correlation with p-value of <0.0001 (Figures 5,6).

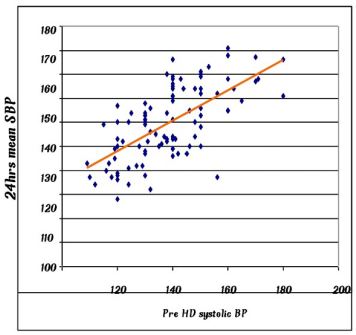

Figure 1) Correlation between pre HD SBP and 24 hrs mean SBP

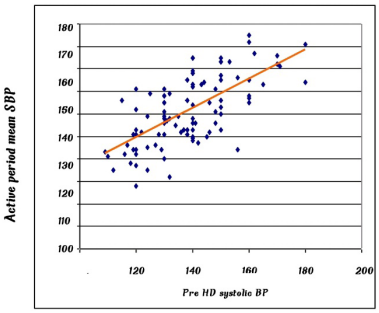

Figure 2) Correlation between pre HD SBP and Active period mean SBP

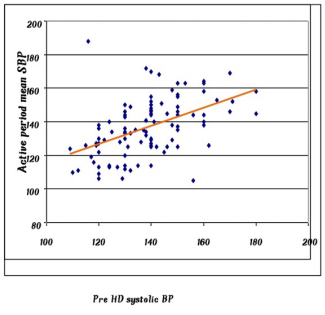

Figure 3) Correlation between pre HD SBP and Passive period mean SBP

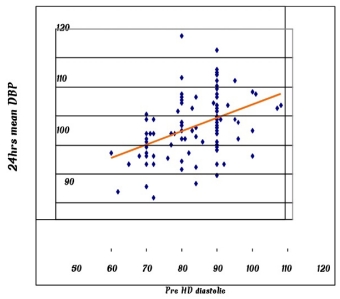

Figure 4) Correlation between pre HD SBP and Passive period mean SBP

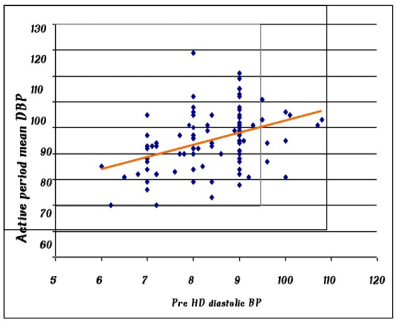

Figure 5) Correlation between pre HD DBP and active period mean DBP

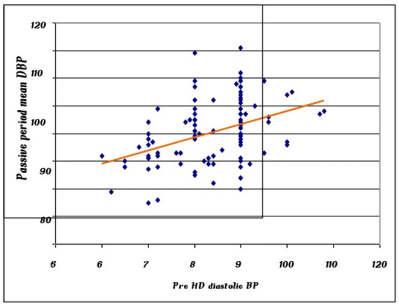

Figure 6) Correlation between pre HD DBP and passive period mean DBP

TABLE 2

Correlation between pre HD SBP and 24hrs mean SBP, active period mean SBP, passive period mean SBP & Correlation between pre HD DBP and 24hrs mean, DBP, active period mean DBP, passive period mean DBP

Correlation between pre HD SBP and	r Value	P Value	S / NS
24 hrs mean SBP	0.652	<0.0001	S
Active period SBP	0.66	<0.0001	S
Passive period SBP	0.484	<0.0001	S
24 hrs mean DBP	0.430	<0.0001	S
Active period DBP	0.414	<0.0001	S
Passive period DBP	0.407	<0.0001	S

TABLE 3

Association between Hypertension as pre HD BP and HTN as ABPM

HTN as pre HD BP	HTN as ABPM		Total
	Yes	No	
Yes	26	9	35
No	22	43	65
Total	48	52	100
Chi-square = 14.91, P<0.0001 Cohen's Kappa Agreement = K =0.372			

TABLE 4

Association between intradialytic HTN (IDH) and HTN as ABPM

IDH	HTN as ABPM		Total
	Yes	No	
Yes	25	6	31
No	35	34	69
Total	60	40	100
Chi-square=7.98, P=0.005			

TABLE 5

Comparison of mean 24hrs, active, passive SBP according to IDH & Comparison of mean 24hrs, active, passive DBP according to IDH

Parameter	Intradialytic HTN				t Value	p Value	S/ NS
	Yes (n=31)		No (n=69)				
	Mean	SD	Mean	SD			
24 hrs mean SBP	148.68	14.112	135.55	13.496	4.43	<0.0001	S
Active period SBP	151.52	14.233	137.39	13.425	4.78	<0.0001	S
Passive period SBP	143.10	14.991	133.68	17.271	2.62	0.01	S
24 hrs mean DBP	87.68	11.473	81.81	10.465	2.52	0.013	S
Active period DBP	89.00	11.824	83.35	10.612	2.38	0.019	S
Passive period DBP	83.77	10.868	78.94	11.531	1.97	0.051	S

TABLE 6

Association between outcome and intradialytic HTN (IDH)

Outcome	Group I (n=69)	Group II (n=31)	Total
Survival	63 (91.30%)	28 (90.32%)	91
Death	06 (8.69%)	03 (9.67%)	09
Total	69	31	100

Association between outcome and Intradialytic hypertension (IDH)

Parameter	IDH		Overall
	Group 2	Group 1	
No of cases	31	69	100
No of events	3	6	9
Censored (%)	90.3	91.3	91
Mean survival time (mths)	5.71	5.79	5.77
SE	0.166	0.083	0.077
95% CI	5.38 – 6.03	5.63 – 5.96	5.62 – 5.92

TABLE 7

Regression Analysis: Predictors / Risk factors for Intradialytic Hypertension (IDH)

	Unstand- Coefficients		Stand- Coefficients	T	P-value
	B	Std. Error	Beta		
(Stable)	-2.721	0.595		-4.577	0.000 (S)
Gender	0.051	0.098	0.048	0.527	0.600
DM	0.069	0.102	0.067	0.679	0.499
HD Vintage	0.003	0.004	0.087	0.905	0.368
CHO	0.003	0.001	0.192	2.146	0.03 (S)
IDWG	0.092	0.059	0.158	1.547	0.126
Frequency of HD	0.175	0.092	0.186	1.905	0.05 (S)
24 hr mean SBP	0.013	0.003	0.408	4.261	0.000 (S)
CCB	-0.027	0.222	-0.012	-0.123	0.903
α - blocker	0.212	0.111	0.227	1.911	0.05 (S)
β -blocker	-0.031	0.112	-0.031	-0.277	0.782
CS	0.004	0.156	0.003	0.028	0.978
0.166	0.166	0.166	0.166	0.166	0.166

Association between HTN as pre-HD blood pressure and HTN as ambulatory blood pressure showed poor agreement (Cohen Kappa agreement K=0.2229) (Table 5). Association between HTN as ABPM and intradialytic hypertension (IDH) showed statistically significant correlation (p=0.005). There was 85% probability of non-having IDH if there was no hypertension in ABPM. (Negative predictive value=0.85) Interdialytic weight gain and cholesterol are modifiable risk factors with appropriate measures, so these observations can potentially guide us to prevent IDH in dialysis patients (Table 6). A follow up interventional study targeting lower IDWG and rigid control of cholesterol will help in confirming the role of these factors in IDH. 24 hour mean SBP was independent risk factor for IDH. Other factors associated with IDH were higher pre-HD SBP, presence of diabetes mellitus, higher cholesterol level, longer HD vintage and IDWG (Table 7).

CONCLUSIONS

• The correlation between intradialytic blood pressure with ambulatory blood pressure was found to be statistically significant.

• Pre-HD SBP correlated with 24 hour mean SBP, active period SBP and passive period SBP.

• Association between HTN as ABPM and intradialytic hypertension (IDH) showed statistically significant correlation. There was 85% probability of not having IDH if there was no hypertension in ABPM.

• Interdialytic weight gain and cholesterol are modifiable risk factors.

• Pre-HD SBP and 24 hour mean SBP were independent risk factor for IDH.

LIMITATIONS

• Smaller study population.

• Shorter duration of follow up.

RECOMMENDATIONS

• A larger study with a longer follow up will be helpful in determining the role of ABPM in management of hypertension in patients with chronic kidney disease on maintenance hemodialysis.

• It will also help in better understanding of risk factors, management, morbidity and mortality in patients with IDH.

• Interventional study of targeting control of IDWG and cholesterol would be beneficial.

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