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Original Article

Internal Medicine Section

Role of Ambulatory Blood Pressure Monitoring in Chronic Hypertensive Patients on Antihypertensive Therapy-A Cross-sectional Study

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ABSTRACT

Introduction: Regular monitoring of blood pressure in chronic hypertensive patients on antihypertensive therapy is essential to assess cardiovascular events and to prevant target organ damage.

Aim: The present study was undertaken as an attempt to correlate the relation between random blood pressure monitoring and 24 hour Ambulatory blood pressure monitoring in chronic hypertensive patients on therapy and to assess the efficacy of antihypertensive medication in chronic hypertensive patients.

Materials and Methods: The study was undertaken as a prospective cross-sectional study among 100 patients during the period of June 2015 to June 2016 using convenient sampling technique. As per Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High blood Pressure (JNC 7) guidelines, cases of diagnosed hypertension on regular medication and on follow-up in the outpatient department of General Medicine in a tertiary care hospital were included in the study. Blood pressure was recorded using a mercury sphygmomanometer or aneroid or electronic device as per JNC guidelines. After that Ambulatory Blood Pressure Monitoring (ABPM) device was attached on a belt connected to a standard cuff in the upper arm which uses an oscillometry technique to detect systolic, diastolic and Mean Arterial Blood Pressure (MAP). Descriptive statistics was expressed by means and proportions. Paired t-test was used to find statistically significant difference in related sample observations. A p-value <0.05 was considered statistically significant.

Results: Majority of the study participants were males and were in the age group of 31-40 years. There was a significant difference between random (clinic) blood pressure and ambulatory blood pressure recordings. It was observed that 36 patients (36%) were dippers, 54 patients (54%) were non-dippers, 10 patients (10%) were reverse dippers independent of clinical blood pressure readings.

Conclusion: Ambulatory blood pressure monitoring gives a true estimate of 24 hour readings rather than a single clinic blood pressure which can be influenced by so many factors. It also gives an estimate of other variables like morning surge and nocturnal dip.

Keywords: Cardiovascular events, Dippers, Systolic blood pressure, Target organ damage

INTRODUCTION

Cardiovascular disease is considered to be the top killer disease of all, resulting in more deaths than any other cause worldwide. Systemic hypertension or raised blood pressure is one of the important risk factor for occurrence of cardiovascular diseases [1]. It was estimated in a report by WHO that nearly 40% of the adults aged 25 years and above had raised blood pressure as on 2008 [2]. India is no exception to this higher prevalence of hypertension in adults [3,4] as well as children [5]. Although antihypertensive therapy reduces the risk of cardiovascular and renal disease, large segments of the hypertensive populations are either untreated or inadequately treated [6]. Regular monitoring of blood pressure in chronic hypertensive patients on antihypertensive therapy is essential to assess and prevent cardiovascular events and target organ damage. In the past 30 years, the technique for measuring blood pressure has undergone a substantial change. These methods include repeated measurements of blood pressure using traditional technique, self-measurement of blood pressure in the home or work place, and ambulatory blood pressure measurement using automated devices [7]. Office blood pressure measurement is limited by a number of factors like patient preparation, positioning of the patient, cuff size, cuff placement, inherent variability of blood pressure and observer error. ABPM is being increasingly recommended for routine clinical practice [8]. JNC 7 recommended ABPM for white coat hypertension (a patient's feeling of anxiety in a medical environment results in an abnormally high blood pressure), labile hypertension, resistant hypertension, hypotensive episodes and postural hypotension [9]. Abnormal values are awake: >135/85 mm Hg, asleep: >120/75 mmHg and average: >130/80 mmHg and nocturnal dip: <10% [10]. Conventional clinic measurement is influenced by many factors which make the technique unsuitable for research into drug efficacy, but more importantly, clinic blood pressure measurement cannot provide the assessment of duration of effect nor the effect of antihypertensive on blood pressure at night time. There is some evidence that hypertensive patients who do not have a nocturnal fall in blood pressure (non dippers) are at greater risk than the majority who show significant reduction in nocturnal blood pressure (dippers) [11]. If it can be confirmed that non-invasive ambulatory blood pressure measurement is free of any placebo effect then it is possible that the design of antihypertensive drug could be greatly simplified [12]. Review article by Pickering TG et al., mentions ambulatory blood pressure predicts cardiovascular events better than clinic blood pressure does [13]. Most of the studies used some measure of the mean level of ambulatory blood pressure, but it is unclear which component of the 24 hour ambulatory blood pressure profile gives the best predilection of risk. Persons with non-dipping pattern are higher risk than dipping patterns [14]. However, there are limited studies in India correlating

various ABPM parameters and blood pressure measured in clinics among hypertensive patients. The present study was undertaken as an attempt to study the relation between random clinical blood pressure monitoring and 24 hour ABPM in chronic hypertensive patients on therapy and to assess the efficacy of antihypertensive medication in chronic hypertensive patients.

MATERIALS AND METHODS

The present study was carried out as a prospective cross sectional study among the 100 patients seeking care from the Department of General Medicine, Base Hospital Delhi for chronic hypertension. Base Hospital is a tertiary care referral hospital catering to a diverse population of the personnel serving in the armed forces and their dependent family members. The study was carried out during the period of June 2015 to June 2016. Convenient sampling technique was used to select patients for participating in the study from all eligible patients who attended the hospital for care. As per JNC 7 guidelines 100 cases of diagnosed hypertension (controlled and uncontrolled both) on regular medication and on follow-up in the outpatient department of tertiary care hospital were included in the study. Individuals who have not given consent for study and those with acute illness and are critically ill were excluded from the study. Sample size was calculated keeping in view at the most 5% risk, with minimum 80% power and 5% significant level (significant at 95% confidence level). All the study subjects were explained in detail about the purpose and methodology of the study. Informed written consents were obtained from the study participants before including them in the study. Institute Ethical Committee approval was obtained before the study was begun. (Ethical committee approval no BHDC/EC/13-2015).

Brief procedure: Patients with chronic hypertension on regular follow-up in the outpatient department were initially advised to take rest for five minute in a chair with feet on the floor and arm supported at the heart level. Patients were asked to avoid caffeine, exercise and smoking at least 30 minute prior to measurement, since these factors may cause a transient raise in blood pressure as per JNC guidelines. An approximately sized cuff (cuff bladder encircling at least 80% of the arm) was used to ensure accuracy. After that blood pressure was recorded in right arm supine position, date and time were also noted. At least two measurements were taken and average was estimated. After that ABPM device was attached on a belt connected to a standard cuff in the upper arm which uses an oscillometry technique to detect systolic, diastolic and MAP. To ensure validity at least three readings were recorded simultaneously using a calibrated sphygmomanometer connected to the ABPM monitoring device by a Y connector. Average reading from ABPM and sphygmomanometer should not be differ by more than 5 mmHg. Patient was advised to continue with their daily normal activities preferably in a working day rather than a rest day. When the cuff start to inflate the patients were asked to stop moving and talking as it can impede readings. Keep the arm still and relaxed and breathe normally. They should avoid any activities that interfere with the device such as vigorous exercise. A brief diary to record timing of activities, sleep, taking medication, posture and symptoms related to blood pressure was maintained by the study participants. The ABPM machine records blood pressure after every 30 minute while undergoing daily normal activities including sleep. It is to be removed after 24 hour period. When complete, the device is connected to a computer that prepares a report of the 24 hour (day time, night time and sleep). Average systolic and diastolic ambulatory blood pressure is recorded and validated with manual blood pressure.

STATISTICAL ANALYSIS

Data were recorded on a predesigned performa and managed on an excel spread sheet. All entrees were checked for any keyboard error. A database was created in MS Excel and analysed using Statistical Package for Social Science (SPSS) version 21.0. Descriptive statistics was expressed by means and proportions. Paired t-test was used to find statistically significant difference in related sample observations. A p-value <0.05 was considered statistically significant.

RESULTS

Majority of the study participants were in the age group of 31-40 years (36%) and majority were males (80%). The mean duration for which the study participants were suffering from hypertension was 7.2±3.2 years [Table/Fig-1]. Nearly 78% had clinic systolic blood pressure greater than 24 hour ambulatory systolic blood pressure, 21% had clinic systolic blood pressure less than 24 hour ambulatory systolic blood pressure and 1% had similar readings. About 72% had clinic diastolic blood pressure greater than 24 hour ambulatory diastolic blood pressure, 25% had clinic diastolic blood pressure less than 24 hour ambulatory diastolic blood pressure and 3% had similar readings [Table/Fig-2]. There was a significant difference between random (clinic) blood pressure and ambulatory blood pressure awake, asleep and overall [Table/Fig-3]. It was observed that 36 patients (36%) were dippers, 54 patients (54%) were non-dippers, 10 patients (10%) were reverse dippers independent of clinical blood pressure [Table/Fig-4].

Characteristics	Number (%)
Age (in years)	
<30	18
31-40	36
41-50	28
>50	18
Mean±SD	46±4.2
Gender	
Male	80
Female	20
Duration of Hypertension (in years)	
Mean±SD	7.2±3.2
Antihypertensive drug used for treatment	
ACE inhibitors	8.4
Beta blockers	13.3
Calcium channel blockers	18.7
ACE inhibitor+Diuretics	31.4
Calcium channel blockers+Beta blockers	20.9

[Table/Fig-1]: Distribution of study participants based on demographic characteristics (n=100).

DISCUSSION

The present study confirms the findings that the reduction in clinic systolic and diastolic blood pressure varies significantly with the reduction in ambulatory blood pressure recordings. There is a wide variation between two methods of assessing antihypertensive treatment. There was significant difference between clinic random blood pressure and average, day time and asleep ambulatory blood pressure. The present study also shows that the maximum and minimum blood pressure recordings in ABPM also differs drastically from clinic blood pressure, which in turn implies that any random clinic blood pressure recording may grossly change the treatment profile. The present study also strengthens the fact that blood pressure patterns like morning surge, nocturnal dip predicts the cardiovascular outcome and target organ damage which is one of the primary targets of antihypertensive medication and can be analysed from 24 hour ABPM only. For a hypertensive on drugs, his/her clinic blood pressure may be normal, but he/she may be a non-dipper which significantly affect the cardiovascular events. It may also help in

Age group (in years)	<30			31-40			41-50			>50			Overall		
Parameter	Mean±SD	Mean Diff.	p-value*	Mean±SD	Mean Diff.	p-value*	Mean±SD	Mean Diff.	p-value*	Mean±SD	Mean Diff.	p-value*	Mean±SD	Mean Diff.	p-value*
Clinic SBP	137.78 ±18.09	Ref		138.3 ±17.69	Ref		143.14 ±22.63	Ref		144.11 ±16.58	Ref		140.58 ±18.99	Ref	
Ambulatory SBP (Awake)	133.83 ±14.01	3.94	0.063	133.95 ±13.74	4.35	0.028	136.50 ±16.33	6.64	0.018	138.61 ±18.57	5.5	0.035	135.47 ±15.34	5.12	<0.001
Ambulatory SBP (Asleep)	118.61 ±13.59	19.17	<0.001	120.86 ±17.46	17.43	<0.001	122.07 ±16.61	21.07	<0.001	128.17 ±19.6	15.94	<0.001	122.1 ±17.04	18.49	<0.001
Ambulatory SBP (Overall)	129.17 ±12.73	8.61	0.002	130.41 ±13.63	7.89	<0.001	132.61 ±15.94	10.54	0.001	136.06 ±18.25	8.06	0.004	131.8 ±15.0	8.78	<0.001
Maximum SBP (Overall)	156.83 ±15.15	19.06	<0.001	161.51 ±17.25	23.22	<0.001	166.79 ±21.34	23.64	<0.001	166.56 ±21.81	22.44	<0.001	163.04 ±19.08	22.46	<0.001
Minimum SBP (Overall)	97.78 ±14.18	40.0	<0.001	95.81 ±16.96	42.49	<0.001	97.36 ±19.74	45.79	<0.001	102.67 ±12.11	41.44	<0.001	97.81 ±16.54	42.77	<0.001
Clinic DBP	80.78 ±20.4	Ref		86.0 ±12.06	Ref		90.75 ±14.73	Ref		86.61 ±11.78	Ref		86.5 ±14.71	Ref	
Ambulatory DBP (Awake)	82.83 ±8.97	2.06	0.651	84.46 ±9.64	1.54	0.276	86.93 ±10.72	3.82	0.057	84.94 ±7.46	1.76	0.319	84.94 ±9.47	1.55	0.168
Ambulatory DBP (Asleep)	73.44 ±9.31	7.33	0.133	75.95 ±11.6	10.05	<0.001	78.11 ±11.36	12.64	<0.001	76.67 ±6.79	9.94	0.001	76.23 ±10.41	10.27	<0.001
Ambulatory DBP (Overall)	79.94 ±8.54	0.83	0.854	82.38 ±9.6	3.62	0.016	84.29 ±10.54	6.46	0.004	82.67 ±6.37	3.94	0.039	82.52 ±9.19	3.97	0.001
Maximum DBP (Overall)	109.5 ±18.46	28.72	<0.001	114.08 ±20.50	28.08	<0.001	115.07 ±22.75	24.32	<0.001	107.56 ±15.34	20.94	<0.001	112.38 ±19.94	25.88	<0.001
Minimum DBP (Overall)	54.56 ±14.06	26.22	<0.001	56.22 ±13.0	29.78	<0.001	55.46 ±12.55	35.29	<0.001	56.5 ±10.9	30.11	<0.001	55.76 ±12.56	30.73	<0.001

[Table/Fig-2]: Distribution of study participants based on Clinic BP and various ABPM parameters among different age groups (n=100).
*Paired t-test was used

Parameter	Mean±SD	Mean Diff.	p-value*
Clinic SBP	140.58±18.99	Ref	
Ambulatory SBP(Awake)	135.47±15.34	5.12	<0.001
Ambulatory SBP(Asleep)	122.10±17.04	18.49	<0.001
Ambulatory SBP(Overall)	131.8±15.0	8.78	<0.001
Maximum SBP(Overall)	163.04±19.08	22.46	<0.001
Minimum SBP(Overall)	97.81±16.54	42.77	<0.001
Clinic DBP	86.50±14.71	Ref	
Ambulatory DBP(Awake)	84.94±9.47	1.55	0.168
Ambulatory DBP(Asleep)	76.23±10.41	10.27	<0.001
Ambulatory DBP(Overall)	82.52±9.19	3.97	0.001
Maximum DBP(Overall)	112.38±19.94	25.88	<0.001
Minimum DBP(Overall)	55.76±12.56	30.73	<0.001

[Table/Fig-3]: Distribution of study participants based on Clinic BP and ABPM values (n=100).
*Paired t test was used

Dip pattern	Systolic	Diastolic
Dippers	36%	36%
Non Dippers	54%	54%
Reverse Dippers	10%	10%

[Table/Fig-4]: Distribution of study participants based on dippers, non-dippers and reverse dippers (n=100).

choosing appropriate class of drug and timing of antihypertensive in achieving uniform reduction in blood pressure over 24 hours. Clinic blood pressure does not take into consideration all these variables; it is inaccurate to titrate antihypertensive based on a single or couple of office blood pressure recordings. Therefore, clinic blood pressure regardless of the time should always be analysed with 24 hour ABPM in predicting the antihypertensive efficacy of drug and titrating it. In present research and clinical experience, the discomfort of the ABPM procedure and the extra visit to the clinic that is required for analysis, limits its applicability in routine clinical practice. Purchase of ABPM machine with the software requires a modest initial investment by the medical team (approximately 1.5 lac) which may be little high for an Indian rural set up, but would lead to fewer hospital admissions for accelerated hypertension and reduce the visit to doctor for hypertension management. Despite the inconvenience and cost effects, and other independent variables mentioned above, the authors strongly recommend the routine of ABPM in titrating antihypertensive medications in chronic hypertensive patients.

Rugnath T et al., in their study observed a poor correlation was found between the casual office blood pressure readings and the 24-hour ambulatory blood pressure readings in the white coat hypertensive group compared with the true hypertensive group [15]. Shapiro AP et al., in a retrospective record based study stated that the 24-hour blood pressure averages were generally lower than the casual blood pressure measurements taken in the clinic [16]. Taylor RS et al., used ABPM values to classify blood pressure control and observed that ABPM showed results similar to that of clinic blood pressure, however, 24 hour ABPM showed a higher rate of unsatisfactory control as compared to that of clinic blood pressure criterion [17]. These findings observed in the above studies were comparable to that of the present study results. Gardner SF et al., demonstrated in their study that 24 hour ABPM in general practice provided valuable information to decide on patients who had isolated office hypertension and in deciding drug regimen for patients with

diabetes, suspected resistant hypertension, or drug-induced alterations in blood pressure [18]. Daneshwar A and Mirzazadeh A, in their study concluded that blood pressure assessments in the clinics may not always represent usual awake ambulatory blood pressure among patients with systemic hypertension receiving treatment [19]. These conclusions were in agreement with that of the observations noted in the present study. In a study by Grossman E et al., concluded that ABPM predicts cardiovascular events better than clinic blood pressure levels [20]. In a study by Hermida RC et al., sleep time ambulatory blood pressure as a novel therapeutic target for cardiovascular risk reduction concludes that the diagnosis of hypertension and clinical decision regarding its treatment are typically based on day time clinical blood pressure measurements, occasionally supplemented by wake time patient self-assessment. Yet, correlation between blood pressure level and target organ damage, cardiovascular risk and long term prognosis is higher for ABPM [21]. In a study regarding the value of 24 hour blood pressure monitoring to assess the efficacy of antihypertensive treatment by O Brein E, concluded that it provides a profile of blood pressure behavior over 24 hour period rather than the snap shot provided by the clinic blood pressure [22]. The final outcome of all these studies is in concurrence with present results. Potential advantages and disadvantages of the technique must considered before recommending ABPM for a hypertensive patient [23].

LIMITATION

Possible weakness of the study could be that results may have been influenced by the effects of drugs (e.g., peak and trough effects) may have a greater influence on the variance of clinic blood pressure readings than 24 hour ambulatory readings. The present study also did not take into account the effects of other comorbidities, smoking, alcohol and sex ratio of the participants which may have influenced clinic blood pressure. The present study was not designed to address the effects of individual drugs or classes of drugs; therefore, patient was allowed to take all classes of drugs, which were administered at the discretion of their physicians.

CONCLUSION

Ambulatory blood pressure monitoring is mandatory in assessing antihypertensive effects of drugs both in clinical practice and clinical trials in spite of the cost constraints. It gives a true estimate of 24 hour readings rather than a single clinic blood pressure which can be influenced by so many factors. It also gives an estimate of other variables like morning surge, nocturnal dip and many other derived indices like smoothness index which are better predictors of cardiovascular outcome.

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