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A STUDY OF AMBULATORY BLOOD PRESSURE MONITORING PARAMETERS IN HYPERTENSIVE PATIENTS WITH AND WITHOUT DIABETES MELLITUS

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ABSTRACT

BACKGROUND - Hypertension is a leading risk factor for many life threatening conditions. Large segments of the hypertensive population are untreated or inadequately treated and are prone to develop stroke, myocardial infarction or peripheral arterial diseases. When diabetes co-exists with hypertension the cardiovascular morbidity becomes magnified. Ambulatory blood pressure monitoring (ABPM) parameters has been shown to correlate more closely than office-measured BP with surrogate markers of end-organ damage, thus optimizing treatment and improving patient outcome.

OBJECTIVE - 1. To correlate between the ambulatory blood pressure patterns in hypertensive patients with and without type 2 diabetes melitus. 2.To correlate between ambulatory blood pressure patterns and presence of left ventricular hypertrophy in hypertensive patients.

METHODOLOGY - Our study was a cross-sectional case control study conducted in K R Hospital attached to Mysuru Medical College, Department of Medicine, from Jan 2019 to June 2020. The study included 120 hypertensive patients of which 59 patients had diabetes and 61 patients were non- diabetic. Their office BP values were recorded as the mean of three consecutive measurements. Ambulatory BP was recorded over 24 hours. They were subjected to 2D echo to assess end organ damage.

RESULTS - Our study showed that among 120 hypertensive patients 76 patients had uncontrolled mean ABPM values whereas 85 patients had nocturnal hypertension. Circadian ABPM values showed 45% patients were dippers and 38.3% of patients were found to be non-dippers. But among the diabetes group, 32.2% patients were dippers, whereas 44.1% of patients were found to be non-dippers. ABPM values were higher in patients with left ventricular hypertrophy (LVH).

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 12, 2023

CONCLUSION - Diabetic patients with hypertension had significant alterations in the circadian ABPM patterns with a characteristic blunting of nocturnal dipping. ABPM values showed better correlation with the presence of end organ damage. This validates the use of ABPM in all diabetic patients

KEY WORDS - Hypertension, Diabetes, ABPM, LVH

INTRODUCTION

Hypertension is one of the leading causes of the global burden of diseases. The global burden of hypertension is rising and projected to affect 1.5 billion persons, which is one – third of the world's population by the year 2025. [1]

The asymptomatic nature of the condition delays diagnosis. In most patients who are diagnosed with hypertension, a single disease causing mechanism cannot be identified and treatment remains empiric, often requiring three or more pharmacologic agents with complementary mechanisms of action. Effective treatment requires continuity of care by a knowledgeable physician and frequent medical check up which are less common in low income minorities. Pill burden, prescription drug costs, medication side effects and insufficient time for education of patients contributes to non adherence. [2] Presently, hypertension remains the most common, readily identifiable and reversible risk factor for myocardial infarction, stroke, heart failure, atrial fibrillation, aortic dissection and peripheral arterial disease. Ambulatory Blood Pressure Monitoring (ABPM) enables to monitor blood pressure over a period of 24 hours. BP is recorded every 15 to 30 mins in the daytime and every 30 to 60 mins in the night. This method eliminates observer bias. The large numbers of readings obtained during the patient's daily activities provide a superior assessment of the true BP and can be used for the diagnosis of HTN. Its other advantages are

- It correlates better with cardiovascular outcome than clinic BP levels. [3]
- It enables BP to be assessed throughout the circadian cycle to determine fluctuations in BP and the efficacy of antihypertensive therapy
- It helps to identify white coat hypertension and masked hypertension.
- It provides information on early morning BP surge.
- It helps to determine ambulatory arterial stiffness index
- It helps to identify progression of kidney disease. The nocturnal fall in bp is attenuated in patients with polycystic kidney disease or IgA nephropathy. [4]

The use of ABPM in diabetes has become relevant today for many reasons. ABPM helps to identify masked hypertension which is frequent among diabetics and increases risk for end organ damage. Diabetes is associated with peculiar circadian BP patterns. The circadian decline rate of SBP is closely related to the prevalence of diabetes and fasting glucose negatively correlates with the decline rate of nocturnal SBP.

Physiologically, BP falls by >10% during nighttime (asleep). When BP falls by <10% during nighttime, it is defined as non-dipping. Nocturnal non-dipping is associated with increased risk of stroke, end-organ damage, and cardiovascular events including death. Non-dipping is common in diabetic patients and may reach a prevalence of 30%.

The mechanisms for the attenuated BP decline during sleep are -

- Subjects with type 2 diabetes are more likely to have obesity-associated obstructive sleep apnea, a recognized cause for nondipping.
- Orthostatic hypotension, which is more common in diabetic patients owing to

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 12, 2023

autonomic neuropathy. [5]

- Hyperinsulinemia may activate mitogen-activated protein kinase pathway, which leads to smooth muscle cell proliferation, increased stiffness and elevated BP variations. [6]
- Diabetic nephropathy, heart failure, and perhaps a more general form of salt retention might dampen the BP reductions expected during sleep-related sympathetic withdrawal.

Ambulatory BP control has been shown to be more closely associated with target organ damage of the brain, heart, and kidney than glycemic control, and this gives evidence that ambulatory BP control is effective in preventing future risk of cardiovascular disease in patients with diabetes. [7]

OBJECTIVES

1. To correlate between the ambulatory blood pressure patterns in hypertensive patients with and without type 2 diabetes mellitus. 2.To correlate between ambulatory blood pressure patterns and presence of left ventricular hypertrophy in hypertensive patients.

METHODS

Our study was a cross-sectional case control study conducted in K R Hospital attached to Mysuru Medical College, Department of Medicine, from Jan 2019 to June 2020. It included 120 hypertensive patients of which 59 patients had diabetes and 61 patients were non-diabetic. The study was conducted satisfying all the inclusion and exclusion criteria mentioned below after obtaining consent from the study participants and clearance from the institutional ethical committee.

INCLUSION CRITERIA

Patients in the age group of 18-80 years diagnosed with hypertension. Hypertension diagnosed as SBP >140 mmHg and DBP > 90 mmHg as per clinic measurements.

EXCLUSION CRITERIA

Hypertensive patients were excluded if

<18 or >80 yrs
Pregnant
females
Have night work employment
Have sleep apnoea syndrome
Have evidences of coronary or cerebrovascular atherosclerotic
diseases Cannot tolerate ABPM
Have history of any arrhythmia, congestive heart failure, COPD, hepatic failure and type 3, 4 and 5 kidney failure.

To measure office BP, the patients were seated for 5 minutes and BP was recorded with a sphygmomanometer. Three consecutive measurements were taken and the mean value was considered.

Patients diagnosed with hypertension were selected. Detailed history was taken and a simple questionnaire was completed by each patient. The patients were then subjected to 2D echo.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 12, 2023

Ambulatory BP was recorded over 24 hours and set to measure every 30 min at daytime (from 7:00 AM to 11:00 PM) and every 60 min at night time (from 11:00 PM to 7:00 AM). The monitor was installed on the non-dominant arm. The patients were asked to take activities as usual and avoid daytime napping and sleep for 6 h to 12 h.The occurrence of unusual events or poor sleep were noted.

The following values were calculated from 24 hour BP monitoring -

- Mean 24 hour systolic values
- Mean 24 hour diastolic values
- Daytime SBP and DBP
- Night time SBP and DBP
- Nocturnal BP values were divided as dippers (10-20% SBP fall), non dippers (0-10% SBP fall) and reverse dippers (rise in SBP).

Values of SBP <70 or >250 mmHg, DBP <40 or >150 mmHg and HR <40 or >150 beats per minute were excluded from the study.

MAKING A DIAGNOSIS OF HYPERTENSION BASED ON ABPM VALUES

- A 24 hour mean of 130/80 mmHg or above
- Daytime (awake) mean of 135/85 mmHg or above
- Night time (asleep) mean of 120/70 mmHg or above

IMPORTANT DEFINITIONS

- Hypertension was classified using thresholds of office BP of ≥140/90 mmHg and ABPM mean BP of ≥ 130/80 mmHg.
- White coat hypertension is the office BP ≥140/90 mmHg and ABPM mean BP of <130/80 mmHg.
- Masked hypertension is the office BP of <140/90 mmHg and ABPM mean BP ≥130/80 mmHg.
- Persistent Hypertension (PHT) is the office BP ≥140/90 mmHg and ABPM mean BP ≥130/80 mmHg.
- Controlled Hypertension (CHT) office BP <140/90 mmHg and ABPM mean BP<130/80 mm Hg.

STATISTICAL ANALYSIS

Analysis was done by using Cramer's V test, Independent-Samples T Test, Repeated measure ANOVA and level of significance chosen at $p<0.05$.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 12, 2023

RESULTS

In the present study, a total of 120 hypertensive patients with and without diabetes in the ratio of 1:1 were included according to inclusion criteria.

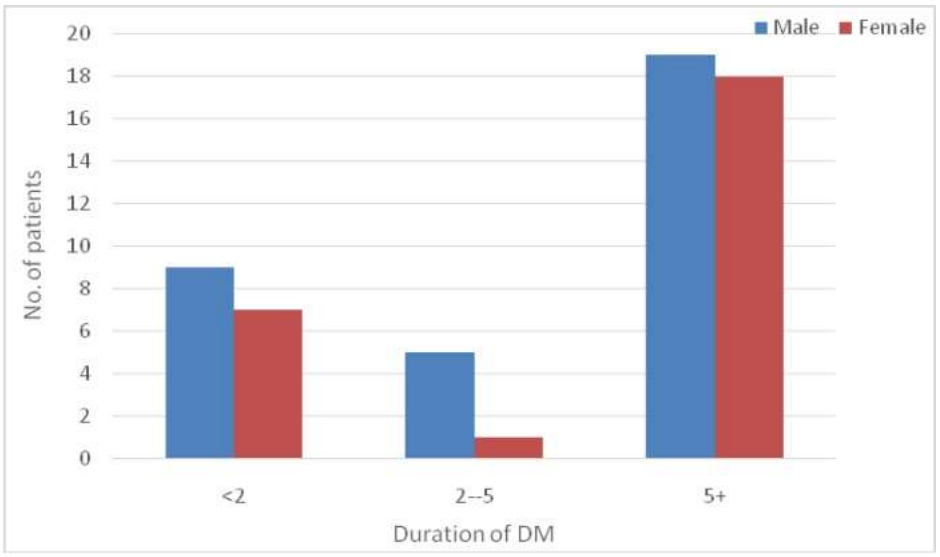

Figure 1: Sex distribution and duration of hypertension

In our present study, the prevalence of hypertension among males was 61.7% and females was 38.3%. 47.5% patients were in the age group of 41-60 years. 45.8% of the patients were started on anti hypertensive medication since 2 years.

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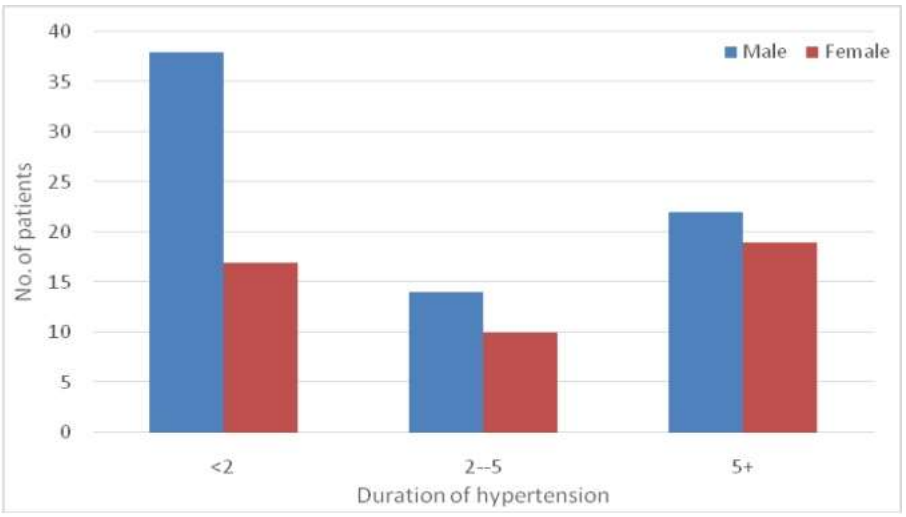


Figure 2: Sex distribution and duration of diabetes mellitus

In our study, 59 patients had diabetes out of which 42 patients were in the age group of 51-70

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 12, 2023

years with 37 patients taking treatment for diabetes for more than 5 years. The prevalence among men was 55.9% and women was 44.1%.

Figure 3: 24 hour variation of systolic ABPM

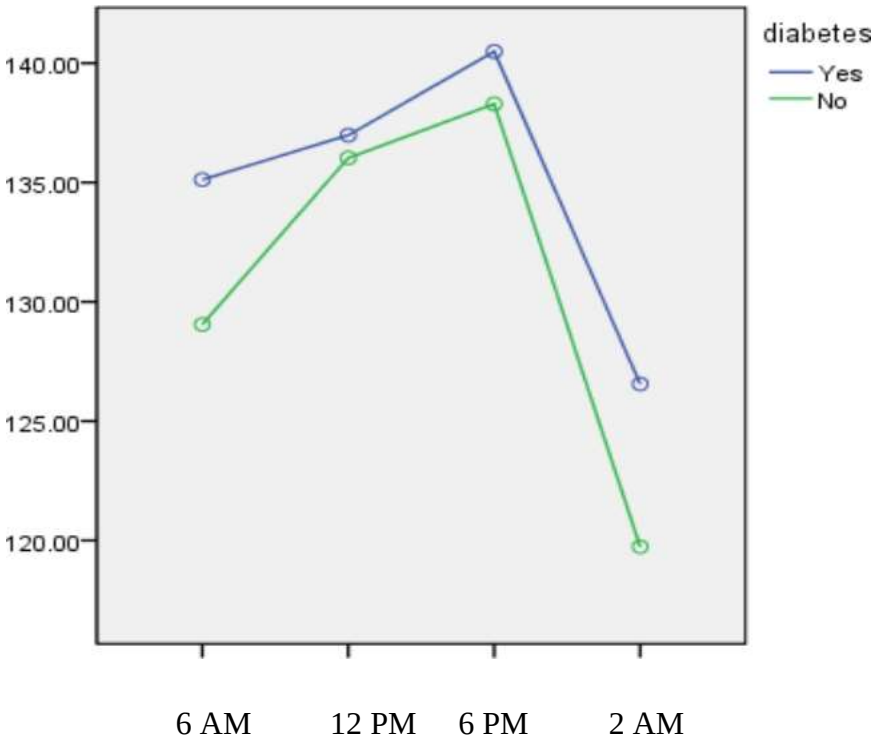
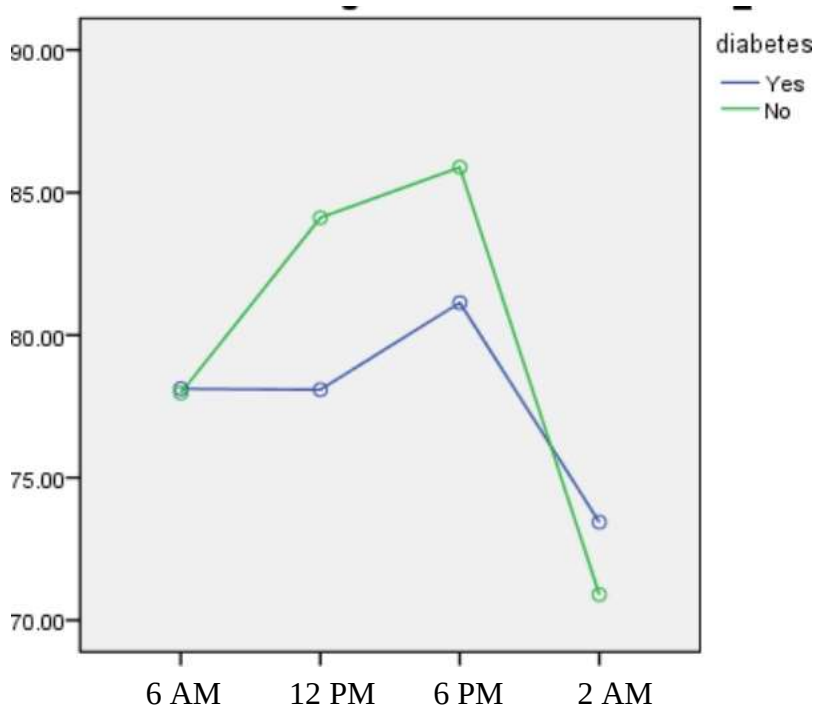


Figure 4: 24 hour variation of ABPM diastolic BP



ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 12, 2023

Our study shows that ABPM values were highest in patients in the evening between 4 and 8 PM and least values were recorded early in the morning between 2 and 4 AM. It was also observed that systolic ABPM values were higher in diabetes patients when compared to the non diabetes patients. Both SBP and DBP values of diabetic patients were especially higher in the night when compared to non diabetic patients.

Table 1 : Ambulatory Blood Pressure Monitoring mean among hypertensive patients with and without diabetes

	Diabetes		**Total**
	Yes	**No**	
Daytime			
Controlled hypertension	**20**	**27**	**47**
Persistent hypertension	**39**	**34**	**73**
Nocturnal			
Controlled hypertension	**14**	**21**	**35**
Persistent hypertension	**45**	**40**	**85**
Mean			
Controlled hypertension	**20**	**24**	**44**
Persistent hypertension	**39**	**37**	**76**

Table 1 shows that among 120 hypertensive patients 76 patients had uncontrolled mean ABPM values whereas 73 patients had uncontrolled daytime ABPM values. 85 patients had nocturnal hypertension.

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 12, 2023

Table 2 :Presence of White Coat and of masked hypertension among hypertensives patients with and without diabetes

Hypertension	Diabetes		Total	
	Yes	No		
White Coat				
Yes	**11**	**13**	**24**	
No	**48**	**48**	**96**	
Masked				
Yes	**14**	**12**	**26**	
No	**45**	**49**	**94**	

Table 2 shows that 24 patients had White coat hypertension out of which 11 had diabetes. Masked hypertension was present in 26 patients out of which 14 were diabetic.This association was not statistically significant.

Table 3: Circadian ABPM patterns in hypertensive patients with and without diabetes

ABPM patterns	Diabetes		Total
	Yes	No	
Dipper	19	35	54
Non-Dipper	26	20	46
Reverse dipper	11	5	16
Extreme dipper	3	1	4

In our study, 45% patients were dippers and 38.3% of patients were found to be non-dippers. But among the diabetes group, 32.2% patients were dippers, whereas 44.1% of patients were found to be non-dippers.The association of non-dipper status with diabetes was found to be statistically significant ($p < 0.001$).

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 12, 2023

CORRELATION OF ABPM VALUES WITH END ORGAN DAMAGE

Table 4: Clinic BP recordings in hypertensive patients with LVH

Blood pressure	LVH		Total
	Yes	No	
Controlled	19	38	57
Not Controlled	35	28	63

Table 5 :Comparison of mean ABPM and of nocturnal ABPM with LVH

Blood pressure	LVH		Total
	Yes	No	
Mean ABPM			
Controlled	**10**	**34**	**44**
Not Controlled	**44**	**32**	**76**
Nocturnal ABPM			
Controlled	**6**	**29**	**35**
Not controlled	**48**	**37**	**85**

In our study, LVH was present in 33% of patients with controlled office BP, 22% patients with controlled mean ABPM values and 17% of patients with controlled nocturnal ABPM values.

Table 6: ABPM patterns in hypertensive patients with LVH

Dipper status	LVH		Total
	Yes	No	
Dipper	11	43	54
Non dipper	28	18	46
Reverse dipper	12	4	16
Extreme dipper	3	1	4

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 12, 2023

In our study it was seen that out of 54 patients who had LVH, 28 patients had non dipper status and 12 patients had reverse dipper status. This association was found to be statistically significant with a p value of 0.0001.

Table 7: Comparison of demographic characteristics and ABPM values among diabetics and non diabetics

Characteristics	Diabetes	Non diabetes
Mean age	61.8	55.4
Male	44.5%	67.2
Female	55.4%	43.47%
Mean ABPM SBP	130.5	127.25
Mean ABPM DBP	78.5	76.25
Nocturnal ABPM SBP	123	117
Nocturnal ABPM DBP	73	69
Masked hypertension	23.7%	19.7%
White Coat hypertension	18.6%	21.3%
Dipper	32.2%	57.37%
Non dipper	44.1%	32.7%
Reverse dipper	18.6%	8.1%
Extreme dipper	5.1%	1.6%
LVH	74%	25.9%

DISCUSSION

The present study included 120 patients out of which 59 had diabetes and 61 patients were non diabetic. The mean age of patients with diabetes was 61.8 years and non diabetics was 55.4 years. The ABPM values of diabetic patients was found to be higher than in non diabetics and this difference was greater in the night, indicating the increased presence of nocturnal hypertension among diabetics. The incidence of non dipper, reverse dipper and extreme dipper pattern of ABPM was more among diabetics than among non diabetics.

Table 8: Comparison of characteristics with other study

Characteristics	Diabetes		Non diabetes	
	Our study	Gorostidi et Al[10]	Our study	Gorostidi et Al[10]
Mean age	61.8	63.8	55.4	57.3
Male	44.5%	55.4%	67.2	52.6%
Female	55.4%	45.6%	43.47%	48.4%
Mean ABPM SBP	130.5	133	127.25	129
Mean ABPM DBP	78.5	74.2	76.25	76.3
Nocturnal ABPM SBP	123	126	117	121
Nocturnal ABPM DBP	73	67.4	69	68.6
Dipper	32.2%	31.3%	57.7%	41.4%

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 12, 2023

Non dipper	44.1%	43.3%	32.7%	39.5%
Reverse dipper	18.6%	21%	8.1%	12%
Extreme dipper	5.1%	4.4%	1.6%	7%

Gorostidi et al[10] showed that office systolic BP was higher and office diastolic BP was lower in patients with diabetes than in non-diabetic individuals. Ambulatory systolic BP levels were higher in diabetic patients with respect to that from non-diabetic subjects in every ABPM period, with differences being wider during the night.
Consequently, lack of control of daytime BP and nighttime BP was more frequent within diabetic patients than in their counterparts. A non dipping BP was observed in 64.2% of diabetic patients whereas this abnormality was present in 51.6% of their counterparts.

In our study, only 22.5% of subjects had BP within normal limits according to both office BP and ABPM values. Only office BP values showed that 52.5% had hypertension. This included both white coat and persistent hypertension. When subjected to ABPM, 76 patients (63.6%) had hypertension. This only included persistent hypertension. 85 patients (70.8%) had nocturnal hypertension and daytime ABPM was uncontrolled in 73 patients (60.8%). Study by Hiregoudar et al[6] showed similiar results with 22.9% having controlled hypertension, 45.7% patients having hypertension according to office blood pressure and 67.1% patients having persistent hypertension. Nocturnal hypertension was seen in 66% patients and daytime ABPM was uncontrolled in 52.7% patients.

The incidence of white coat hypertension was 18.6% in our study. This was similar to the incidence of white coat hypertension found in other studies - 10% in Hiregoudar N et al [6], 20% in Eguchi et al [13], 23% in Leitao et al [24] and 37.68% Salagre SB et al. [14]

The incidence of masked hypertension in our study was 23.7%. Other studies had similar findings such as 29.3% in Leitao et al [24] and 31.4% Hiregoudar N et al [6].

Table 9: Comparison of circadian BP patterns in diabetics with other studies

	Our study	**Hiregoudar et al[6]**	**Duggal et al [15]**	**Salagre et al [14]**
Dipper	32.2%	38.6%	45%	61.5%
Non- dipper	44.1%	47.1%	46%	31.8%
Reverse dipper	18.6%	11.4%	3%	6.5%
Extreme dipper	5.1%	2.9%	6%	-

It was observed that prevalence of altered circadian pattern of BP in type 2 diabetes patients was significantly present . [6] This is indicated in table 9 which shows an increased incidence of non- dippers and reverse dippers in hypertensive patients with diabetes.

CONCLUSION

- Study of demographic characters showed that the mean age of hypertensive patients with diabetes was higher and a greater proportion of the affected population was males in all age groups.
- Clinic BP and ABPM values showed that the diabetic patients had higher BP recordings

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 12, 2023

when compared to non diabetic patients. This included both systolic and diastolic values. This difference was more evident in the night time.

- ABPM values showed better correlation with the presence of left ventricular hypertrophy both in diabetic and non diabetic patients.
- Diabetic patients with hypertension had significant alterations in the circadian ABPM patterns with a characteristic blunting of nocturnal dipping. These patients were at a greater risk of developing cardiovascular complications.
- ABPM helped to identify patients white coat hypertension and masked hypertension who are at a greater risk for developing cardiovascular complications when compared to normotensives, This enables to adopt a more aggressive approach to achieve therapeutic targets in these individuals.
- This validates the use of ABPM for all hypertensive patients with or without diabetes.

LIMITATIONS OF THE STUDY

- The study was a cross sectional observational study and no follow up was done to learn the prognosis of the patient.
- Since this study was conducted in a tertiary care hospital, the incidence of uncontrolled hypertension might have been higher than in general population. The incidence of end organ damage might also have been higher than in the general population.

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CONFLICT OF INTEREST : NIL

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