RELATIONSHIP BETWEEN CIRCADIAN BLOOD PRESSURE PATTERN AND CORONARY SLOW FLOW

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ABSTRACT:

Background: *Dipper hypertension referred to a drop of more than 10% in nocturnal blood pressure during the circadian rhythm while a decrease less than 10 % is referred to non-dipper. Coronary slow flow is associated with severe cardiovascular complications myocardial ischemia, malignant arrhythmias, and cardiovascular mortality.*

Aim of the work: *We aimed to examine the relationship between circadian blood pressure pattern and thrombolysis in myocardial infarction (TIMI) frame count, which is an indicator for coronary slow flow.*

Methods: *This is a comparative cross-sectional study that included patients with symptoms of typical chest pain or angina equivalent with or without stress test who underwent elective coronary angiography, and their blood pressures were followed up with ambulatory blood pressure monitoring (ABPM). The patients were divided as dipper and non-dipper hypertensives. The data of ABPM and the thrombolysis in myocardial infarction (TIMI) frame count were compared between the compared groups.*

Results: *A total of 60 patients (26 males and 24 females) were included. Twenty-three patients were in the dipper group and 37 patients in the non-dipper group. Regarding ABPM over 24 hours, the non-dipper group had higher levels in terms of mean BP, mean systolic BP and pulse pressure (PP) than the dipper group. Regarding daytime ABPM, the non-dipper group had higher levels in terms of mean BP, mean systolic BP, and PP than the dipper group. Regarding nighttime ABPM, the non-dipper group had higher levels in terms of mean BP, mean systolic BP, mean diastolic BP, and PP than the dipper group.*

Conclusion: *Coronary slow flow diagnosis with higher TIMI frame count was observed to be higher in non-dipper hypertensive patients in comparison to in dipper hypertensives.*

Keywords: *hypertension, coronary angiography, coronary slow flow, TIMI frame count, dipper, non-dipper.*

INTRODUCTION:

Hypertension represents a substantial risk factor for myocardial infarction (MI), stroke, and, and renal diseases. Management of hypertension may decrease the occurrence of complications and allow longer life. Cardiovascular parameters including blood pressure, heart rate, and coronary tonus variations with the circadian rhythm[1].

Ambulatory Blood Pressure Monitoring (ABPM) is a non-invasive method that involves placing a standard cuff around the upper arm and attaching it to a lightweight, portable data recording unit, which then inflates at regular intervals over a 24-hour period[2]. ABPM is capable of detecting circadian variations, including diurnal rhythmic variations, nocturnal dipping, and

morning surge, as well as changes in blood pressure with different environmental and emotional circumstances[3]. Most cardiovascular complications tend to take place in the early morning hours due to the increasing heart rate and blood pressure response, as well as the initial production of hormones such as cortisol[4].

When blood pressure drops by more than 10% during the night compared to diurnal levels, it is referred to as "dipping". Individuals whose nocturnal blood pressure drops by less than 10% compared to their diurnal blood pressure are classified as non-dippers[5]**.** Nocturnal hypertension can be caused by a variety of factors, such as volume overload, autonomic dysfunction, and sleep disruptions, other lifestyle-related aspects[6].

The coronary slow flow phenomenon (CSFP) is defined as delayed distal vessel opacification in at least 1 epicardial vessel with no significant epicardial coronary stenosis (no lesions ≥40%), which is considered an angiographic clinical entity[7]. CSFP has significant clinical implications, as it has been related to various clinical manifestations such as myocardial ischemia, life-threatening arrhythmias, sudden cardiac arrest, and recurrent acute coronary syndromes. This phenomenon is commonly observed in young male smokers and patients known with acute coronary syndrome. The clinical manifestations of CSFP resemble those of coronary atherosclerotic heart disease. CSFP is not uncommon in clinical practice, and it is confirmed in 1% to 7% of patients who undergo coronary angiography following chest pain. Although the majority of these patients have a good prognosis, chronic and frequent angina can significantly decrease their quality of life[7].

The thrombolysis in myocardial infarction (TIMI) frame count is a measure of the number of cine-frames required for contrast to achieve a specific distal point in the coronary artery, with a normal range of 21±3.5[8]. High TIMI frame counts are associated with slow coronary flow and endothelial dysfunction, making it a useful predictor[9]. Unlike qualitative measures, TIMI frame count is quantitative, continuous, objective, reproducible, and sensitive to changes in flow. The TIMI frame count was initially described for angiograms taken at a rate of 30 frames per second on 35 mm radiographic film[10].

AIM OF THE WORK:

We conducted the current study to evaluate the relationship between circadian blood pressure pattern and thrombolysis in myocardial infarction (TIMI) frame count, which represents coronary slow flow.

PATIENTS AND METHODS:

We conducted this study including patients with symptoms of typical chest pain candidate for coronary angiography at the Cardiology Department, Zagazig University Hospitals and Al-Ahrar Teaching Hospital in the duration between February 2020 and April 2022.

Ethical Considerations:

Patients of the study received a full explanation of the study. Written consent was acquired from each patient. The study was accepted by the medical research and ethics committee at Faculty of Medicine, Zagazig University (ID:5619-13-10-2019).

Inclusion and exclusion criteria:

The study data were obtained from patients with symptoms of typical chest pain or angina equivalent with or without stress test who undergoing elective coronary angiography who had normal CAG or with CSFP with arterial blood pressure follow-up by ABPM. We excluded patients who exhibited obstructive coronary artery disease (with more than 20% stenosis of the luminal area), coronary ectasia, myocardial bridging,

no-reflow phenomenon, major coronary spasm, congenital heart disease, a history of previous myocardial infarction, coronary artery bypass graft surgery (CABG), or percutaneous coronary intervention (PCI), severe valvular heart disease, left ventricular ejection fraction below 50%, renal impairment, and connective tissue disease.

Data collection:

The patient's detailed history, including age, gender, and presenting complaint (with emphasis on the onset, characteristic, frequency, severity, duration, and causative/relieving factors of chest pain) as well as important associated symptoms (such as dyspnea) and medications, were recorded. The patient's history of diabetes mellitus was defined according to the World Health Organization (WHO) criteria, which states that a fasting glucose level greater than 126 mg/dL or treatment with hypoglycemic medications indicates diabetes[11]. Hyperlipidemia was assessed according to the Adult Treatment Panel III (ATP III) standard levels[12]**,** hypertension, and cigarette smoking. General and local examination for every patient was done especially with an emphasis on weight and height for estimating body mass index (BMI) in addition to body surface area (BSA)[13].

Further data were collected on the following: electrocardiography (12 leads ECG), a standard transthoracic echo-cardiogram (TTE) was executed using Siemens ACUSON X300 ultrasound machine with P4-2 1.8 MHZ transducer with tissue doppler imaging capability and vivid S6 ultrasound machine with Prob 4-s. Left ventricular ejection fraction (LVEF) was measured by the M-mode imaging method and modified Simpson's technique following the suggestions of the American society of echocardiography and the European association of cardiovascular imaging (ASE/EACVI). This was done by tracing the endocardial border of LV in its greater and smaller dimensions in diastole and systole respectively. LV systolic dysfunction was described as LVEF <52% in males and <54% in females[14].

Left ventricular mass index (LVMI), assessment of diastolic function including assessment of mitral annular e' velocity, mitral average E/e' ratio, diastolic function, TR jet velocity, left atrial size, pulmonary artery systolic pressure by TR peak velocity, ambulatory blood pressure. Each patient underwent coronary angiography in Zagazig University Hospitals Catheterization laboratories (Cine angiographic equipment: Philips Integris: cine frame: 30 fps) and Al-Ahrar Hospital Catheterization laboratories (Philips Allura). Selective coronary angiography with standard multi-angulated angiographic views was accomplished through the femoral artery under local anesthesia employing the Judkins catheters and telebrix-35 (Ioxitalamic acid) as the contrast agent or Omnipaque (iohexol).

Patients underwent ABPM using the Riester Ri-cardio ambulatory blood pressure monitor, which was validated in accordance with the protocol of the European Society of Hypertension. Follow-up was performed using a tension artery Holter device. ABPM was conducted regardless of the type and duration of antihypertensive drug therapy, with patients instructed to maintain their daily activities and keep their arms straight during measurement. Systolic and diastolic blood pressure levels and heart rate measurements were recorded for both the daytime and nighttime periods, with measurement intervals of 30 minutes. Data were evaluated at the end of the 24-hour period, and patients with more than two hours of missing recordings were either excluded from the study or given another 24 hours of ABPM. Severe sleep disturbance caused by inflations was also a reason for exclusion. The nocturnal BP dipping was calculated using the following equation: nocturnal BP dipping (%) = [(mean daytime SBP - mean nocturnal SBP) / mean daytime SBP] × 100.

Statistical analysis:

The data were analyzed using version 24 of the Statistical Program for Social Science (SPSS). Mean with standard deviation was used to represent quantitative data, while frequency and percentage were used to represent qualitative data. The distribution of the data was tested using the Kolmogorov–Smirnov test. When comparing the means of two groups, an independent-sample t-test was employed. On the other hand, a chi-square test was utilized for comparing non-parametric data. A result was deemed statistically significant if the probability (P-value) was less than 0.05.

RESULTS

This study included 60 patients (26 males and 24 females); of them, 23 patients were in the dipper group, and 37 patients were in the non-dipper group. The mean age was 53.8 ± 7.6 in the dipper group and 57.1 ± 8.2 in the non-dipper group. The demographic and clinical data of the groups were compared and presented in Table.

Patients in the non-dipper group had a statistically significant higher incidence of dyslipidemia (p-value < 0.001), DM (p-value = 0.014), positive family history (p-value = 0.047), increase weight (p-value = 0.007), increased BSA (p-value = 0.003), patients taking BB (p-value = 0.049), patients taking anti-hyperglycemia (p-value < 0.001) when compared to patients with dipper group. However, there were no significant differences (p-value > 0.05) between both study groups regarding age, sex, smoking, height, BMI, medications (CCB, Nitrate, ACEI, anti-platelets, and Statins), and symptoms.

Table 1: Basic characteristics of the studied groups.

	Ambulatory result		P-value
	Dipper	Non-Dipper	
Age (years) Mean ± SD	53.8 ± 7.6	57.1 ± 8.2	0.13
Gender Female, n (%)	9 (39.1%)	17 (45.9%)	0.60
HTN, n (%)	23 (100%)	37 (100%)	0.20
DM, n (%)	5 (21.7%)	20 (54.1%)	0.01
Smoking, n (%)	8 (34.8%)	13 (35.1%)	0.98
Dyslipidemia, n (%)	2 (8.7%)	25 (67.6%)	*< 0.001
Family history, n (%)	7 (30.4%)	21 (56.8%)	*0.047
Height (m) Mean ± SD	1.68 ± 0.08	1.72 ± 0.06	0.09
Weight (kg) Mean ± SD	81.4 ± 11.0	90.8 ± 13.7	*0.007
BMI (kg/m²) Mean ± SD	28.9 ± 4.3	30.8 ± 5.1	0.15
BSA Mean ± SD	1.9 ± 0.1	2.1 ± 0.2	*0.003
Medications			
BB	11 (47.8%)	27 (73%)	*0.049
CCB	8 (34.8%)	14 (37.8%)	0.81
Nitrate	3 (13%)	6 (16.2%)	0.7
ACEI	14 (60.9%)	28 (75.7%)	0.22
Anti-platelets	6 (26.1%)	19 (51.4%)	0.05
Statins	8 (34.8%)	18 (48.6%)	0.29
Anti-hyperglycemia	5 (21.7%)	20 (54.1%)	*0.014
Symptoms			
Typical angina Pain	15 (65.21%)	25 (67.56%)	0.9
Stress test	2 (8.7%)	2 (5.4%)	0.48
Angina equivalent	6 (26.09%)	10 (27.04%)	0.93

HTN, hypertension; DM, diabetes; BMI, body mass index; BSA, body surface area; BB, beta blocker; CCB, Calcium channel blocker; ACEI, Angiotensin-converting enzyme inhibitors.

Patients in the non-dipper group had a statistically significant increased levels of cholesterol (p-value < 0.001), TG (p-value = 0.002), and LDL (p-value = 0.01) when compared to patients in the dipper group. However, there were no significant differences (p-value > 0.05) between both study groups regarding CBC, HDL, creatinine, and RBS. The non-dipper group had a statistically significant increased incidence of LVH (p-value < 0.001), ST depression (p-value = 0.035), increase QT interval (p-value = 0.001), corrected QT interval (p-value = 0.001), QT dispersion (p-value = 0.002), Tp-Te interval (p-value = 0.002) compared to the dipper group. However, there were no statistically significant differences (p-value > 0.05) between the studied groups regarding P wave dispersion, T wave inversion in leads, BBB, Tp-Te/QT, and Tp-Te/corrected QT. The non-dipper group had a statistically significant increased incidence of LVPW (p-value = 0.032), IVS (p-value = 0.024), LV mass (p-value = 0.008), LV mass index (p-value = 0.032) and LA size (p-value = 0.003) compared with the dipper group. However, there were no statistically significant differences (p-value > 0.05) between the studied groups regarding EF, LVEDD, LVESD, RV size, PASP, E/A ratio, and E /E prime ratio.

Table 2: Laboratory findings of the studied groups.

	Ambulatory results mean ± SD	
	Dipper	Non-Dipper
Hb (g/dl)	12.8	13.6
	1.8	2.1
PLTs (x10³/ul)	262.2	253.1
	67.1	76.8
WBCs (x10³/ul)	9.0	8.5
	2.2	2.3
RDW (%)	13.6	14.1
	2.0	2.5
PDW (%)	13.4	13.1
	2.5	2.7
RBS (mg/dl)	153.2	173.0
	69.9	70.5
Creat (mg/dl)	1.14	1.11
	0.20	0.22
CHOL (mg/dl)	174.8	233.9
	38.3	47.0
TG (mg/dl)	131.1	216.4
	54.2	115.8
LDL (mg/dl)	104.3	123.8
	22.6	29.9
HDL (mg/dl)	50.6	47.0
	12.5	9.8

HB, Hemoglobin; PLT, platelets; WBCS, White blood cells; RDW, Red blood cell distribution width; PDW, Platelets distribution width; RBS, Random blood sugar; Creat, creatinine; CHOL, Cholesterol; TG, Triglyceride; LDL, Low-density Lipoprotein Cholesterol; HDL, High-density Lipoprotein Cholesterol.

Table 3: ECG findings of the studied groups.

		Ambulatory results				Stat test	P-value
		Dipper		Non-Dipper			
LVH		1	4.3%	24	64.9%	$X^2 = 21.4$	< 0.001 HS
T wave inversion		5	21.7%	10	27%	$X^2 = 0.21$	0.646 NS
ST depression		2	8.7%	12	32.4%	$X^2 = 4.5$	0.035 S
B.B.B		0	0%	3	8.1%	$X^2 = 1.9$	0.161 NS
P. wave dispersion (ms)	Mean	30.0		31.5		T = 1.05	0.295 NS
	±SD	4.8		5.9			
QT interval(ms)	Mean	362.2		402.2		T = 3.5	0.001 S
	±SD	34.9		45.9			
Corrected QT interval(ms)	Mean	423.0		458.9		T = 4.7	< 0.001 HS
	±SD	19.5		33.0			
QT dispersion(ms)	Mean	35.0		39.1		T = 3.2	0.002 S
	±SD	3.7		5.5			
Tp-Te(ms)	Mean	71.6		80.6		T = 3.2	0.002 S
	±SD	6.9		12.5			
Tp-Te/QT	Mean	0.20		0.20		T = 0.01	0.991 NS
	±SD	0.03		0.03			
Tp-Te/ Corrected QT	Mean	0.17		0.17		T = 1.1	0.252 NS
	±SD	0.01		0.02			

S: p-value < 0.05 is considered non-significant. T: independent sample T test.
HS: p-value < 0.001 is considered highly significant.
X^2: Chi-square test. NS: p-value > 0.05 is considered non-significant.
LVH, Left ventricular hypertrophy; BBB, bundle branch block; Tp-Te, T peak-to-T end Interval

Table 4: Echocardiographic findings of the studied groups.

		ambulatory results		Stat test	P-value
		Dipper	Non-Dipper		
EF %	Mean	61.8	63.1	T = 0.82	0.412 NS
	±SD	5.8	5.8		
LVEDD (cm)	Mean	46.8	49.2	T = 1.4	0.167 NS
	±SD	5.2	6.9		
LVESD (cm)	Mean	31.2	32.4	T = 1.0	0.320 NS
	±SD	4.3	4.6		
LVPW (cm)	Mean	10.02	11.2	T = 2.2	0.032 S
	±SD	2.1	2.3		
IVS (cm)	Mean	10.2	11.5	T = 2.3	0.024 S
	±SD	2.1	2.1		
LV mass (g)	Mean	172	219.9	T = 2.7	0.008 S
	±SD	54.3	72.9		
LV mass index (g/m^2)	Mean	87.7	106.4	T = 2.2	0.032 S
	±SD	27.2	35.4		
LA size (cm)	Mean	34.2	39.6	T = 3.04	0.003 S
	±SD	4.8	7.8		
RV size (cm)	Mean	27.3	25.8	T = 1.74	0.086 NS
	±SD	2.5	3.6		
PASP (mmHg)	Mean	33.8	32.5	T = 0.64	0.524 NS
	±SD	7.6	7.8		
E/A ratio	Mean	1.0	0.9	T = 1.51	0.136 NS
	±SD	0.3	0.2		
E /E prime ratio	Mean	9.0	8.0	T = 1.84	0.071 NS
	±SD	2.5	1.5		

T: independent sample T test. S: p-value < 0.05 is considered significant.

X^2: Chi-square test. NS: p-value > 0.05 is considered non-significant.

EF, Ejection fraction; LVEDD, left ventricular end-diastolic diameter; LVESD, left ventricular end-systolic diameter; LVPW, left ventricle posterior wall; IVS, Interventricular septum; RWMA, Regional wall motion abnormality; LV mass, left ventricular mass; LA, left atrium; RV, Right ventricle; PASP, Pulmonary arterial systolic pressure.

Regarding the ambulatory blood pressure (ABP) over 24 hours, the results showed that the non-dipper group had statistically significant higher levels in terms of mean BP (p-value = 0.008), mean SBP (p-value < 0.001), and PP (p-value < 0.001) compared with the dipper group. However, there were no statistically significant differences (p-value > 0.05) between the studied groups regarding mean DBP and HR. Regarding daytime ABP, the non-dipper group had a statistically significant higher levels in terms of mean BP (p-value = 0.02), mean SBP (p-value < 0.001), and PP (p-value < 0.001) compared with the dipper group. However, there were no statistically significant differences (p-value > 0.05) between the studied groups regarding mean DBP and HR. Regarding nighttime ABP, the non-dipper group had a statistically significant higher levels in terms of mean BP (p-value = 0.001), mean SBP (p-value < 0.001), mean DBP (p-value < 0.001), and PP (p-value < 0.001) compared with the dipper group. However, there were no statistically significant differences (p-value > 0.05) between the studied groups regarding HR, Table 5.

Table 5: Ambulatory blood pressure findings of the studied groups.

Parameters	Ambulatory results (mean ± SD)		P-value
	Dipper	Non-Dipper	
Over 24 hours			
Mean SBP (mmHg)	132.2 ± 11.4	150.8 ± 13.8	*< 0.001
Mean DBP	78.8 ± 8.7	82.3 ± 9.4	0.152
Mean BP	96.6 ± 9.0	107.8 ± 18.3	*0.008
PP (mmHg)	53.4 ± 7.8	68.5 ± 10.0	*< 0.001
HR(b/m)	77.8 ± 8.7	82.2 ± 7.9	0.055
Day time			
Mean SBP	134.6 ± 9.3	149.2 ± 13.6	*< 0.001
Mean DBP	80.8 ± 9.3	82.9 ± 10.1	0.428
Mean BP	98.8 ± 8.6	105.0 ± 10.4	*0.02
PP	53.8 ± 7.9	66.4 ± 9.7	*< 0.001
HR(b/m)	78.8 ± 8.9	82.3 ± 6.7	0.102
Nighttime			
Mean SBP	116.6 ± 9.5	145.6 ± 15.9	*< 0.001
Mean DBP	69.1 ± 7.5	78.2 ± 10.0	*< 0.001
Mean BP	85.2 ± 7.3	100.5 ± 11.3	*< 0.001
PP	47.5 ± 8.0	67.9 ± 12.0	*< 0.001
HR	68.9 ± 7.6	71.3 ± 9.0	0.265

SBP, systolic blood pressure; DBP, Diastolic blood pressure; PP, Pulse pressure; HR, Heart rate. *P-value < 0.05 indicates a statistically significant result.

Patients in the non-dipper group had a statistical significant increased TIMI frame count in RCA (23.7 ± 2.8 vs 22.3 ± 2.6 p-value = 0.048), LCX (26.4 ± 2.7 vs 24.3 ± 2.5 p-value = 0.004), LAD (39.9 ± 2.9 vs 38.1 ± 2.1 p-value = 0.01), corrected LAD TFC (23.5 ± 1.7 vs 22.4 ± 1.2 p-value = 0.01), mean total TIMI frame count (30 ± 2.4 vs 28.2 ± 2.2 p-value = 0.006) when compared with the dipper group, Table 6.

Table 6: TIMI frame count of the studied groups.

TIMI frame count	Ambulatory results (mean ± SD)		P-value
	Dipper	Non-Dipper	
RCA	22.3 ± 2.6	23.7 ± 2.8	*0.048
LCX	24.3 ± 2.5	26.4 ± 2.7	*0.004
LAD	38.1 ± 2.1	39.9 ± 2.9	*0.01
Corrected LAD TFC	22.4 ± 1.2	23.5 ± 1.7	*0.01
Mean total TFC	28.2 ± 2.2	30.0 ± 2.4	*0.006

TIMI, The Thrombolysis in Myocardial Infarction; RCA, right coronary artery; LAD, left anterior descending artery; LCX, Left Circumflex artery; TFC TIMI frame count. *P-value < 0.05 indicates a statistically significant result.

DISCUSSION:

The daily circadian rhythm affects several cardiovascular parameters, including coronary tone, blood pressure, and pulse pressure. If nocturnal blood pressure drops by >10%, it is recognized as dipper hypertension and if the drop is <10%, it is referred to as non-dipper hypertension[5]. The motive behind such distribution is due to the variations in morbidity and death ratios observed between these groups. In patients having non-dipper blood pressure, end-organ failure, such as ventricular hypertrophy, microalbuminuria, reduced arterial compliance, and cardiovascular complications rates are greater[15].

The TIMI frame count is a simple, objective, and reproducible method that quantitatively predicts coronary flow rate. An elevated TIMI frame count is indicative of slow coronary flow and endothelial dysfunction[9]. The aim of our study was to compare the TIMI frame count between dipper and non-dipper hypertensive patient groups with normal CAG. In our study, we found that the non-dipper group had a statistically significant increase in the incidence of TIMI frame count compared to the dipper group for the RCA, LCX, LAD, corrected LAD TFC, and mean total TIMI frame count. In a study by Akşit et al., they also examined the TIMI frame counts in dipper and non-dipper hypertension patients with normal coronary arteries. They found that the dipper group had significantly lower TIMI frame counts than the non-dipper group for the RCA, Cx, LAD, corrected LAD TFC, and mean total TIMI frame count[16].

According to Evola et al.'s study, they examined the TIMI frame counts of 80 hypertensive patients with normal CAG, and compared them to 15 normotensive individuals. Their findings indicated that the hypertensive group had higher TIMI scores. Moreover, they also found that hypertensive patients with positive myocardial perfusion scintigraphy had significantly higher TIMI frame counts compared to those with negative scintigraphy in the same study[17]. The authors of the study inferred from their findings that a high TIMI frame count was indicative of a higher incidence of coronary artery flow and myocardial perfusion disorders. They suggested that myocardial perfusion scintigraphy could be employed as a non-invasive diagnostic tool to detect early changes in the coronary microcirculation. Similarly, Yazici et al. reported that the prevalence of non-dipper patients was significantly superior to dipper patients in a group of patients with slow coronary flow rates. Non-dipper patients with slow coronary flow rates were linked to higher rates of unstable angina-like symptoms, recurrent chest pain, sudden cardiac arrest, and malignant ventricular arrhythmia than dipper patients[18].

Pekdemir et al. utilized intravascular ultrasonography and fractional flow reserve to investigate coronary anatomy and epicardial resistance, highlighting the importance of small-vessel disorder in their study[19]. According to their findings, Pekdemir et al. used intravascular ultrasonography and fractional flow reserve to investigate coronary anatomy and epicardial resistance. They suggested that the development of early diffuse atherosclerosis in patients with slow coronary flow could be linked to an increase in resistance in epicardial coronary arteries[19]. In a separate study, Xia et al. observed a patient group with slow coronary flow and found higher levels of serum uric acid, platelet count, high-sensitivity CRP, and two-hour fasting glucose in comparison to control[20]. The latest epidemiological and experimental research has established that an elevated level of uric acid poses a risk for cardiovascular disease [21, 22].

Cardiovascular and cerebrovascular patients are at risk of endothelial-dependent vasodilation impairment due to reduced nitric oxide release in various arteries, such as brachial, coronary, renal, and small arteries [23-26]. A study conducted by Higashi et al. compared endothelial dysfunction between 20 dipper and 20 non-dipper hypertensive patients. The study identified a decrease in nitric oxide final products nitrite/nitrate and cyclic guanosine monophosphate as predictors of endothelial dysfunction, which were found to be statistically significantly lower in the 24-hour urine samples of non-dipper patients. These findings were consistent with a higher TIMI frame count observed in all three coronary arteries, which could also serve as a predictor of endothelial dysfunction [27].

The present study evaluated 24-hour Holter data of the involved patients and found that the non-dipper group had significantly higher mean ABP, systolic BP, and PP during ABP monitoring over 24 hours. Non-dippers also had significantly higher mean BP, mean SBP, and PP during the day and night compared to dippers. Only diastolic BP was found to be higher in non-dippers during nighttime. Similar findings were reported by Chotruangnapa et al., who found that mean SBP was higher during daytime and nighttime but not over 24 hours. However, unlike our study, they found that DBP was significantly higher in non-dippers during the daytime[28]. Muxfeldt's study showed that the average 24-hour and daytime SBP and DBP values were comparable across the four BP patterns, but there was a gradual increase in night-time BP from extreme dippers to reverse dippers[29]. The results may be attributed to the varying sympathetic activity associated with different BP patterns. According to Grassi et al., reverse dipper patients with high blood pressure were linked to higher sympathetic activity compared to other patients. Yet, the study also indicated a difference in sympathetic activity among dipper, non-dipper, and extreme dipper hypertensive patients, although statistically insignificant, potentially due to a small sample size[30]. Reduced sympathetic activation is linked to a higher likelihood of a decline in nocturnal BP, resulting in a more significant fall in nocturnal BP or a rise in nighttime BP. Another explanation is the connection between insulin resistance and changes in the dipping status. Several researchers have proposed that insulin resistance is connected to non-dipping and reverse dipping status[31].

Limitations:

There were some limitations, such as a small sample size and not testing for other biochemical and echocardiographic indicators that have been related to coronary slow flow. Additionally, the lack of measurement of proximal coronary artery diameters could have affected TIMI frame count, as vasoconstriction due to increased sympathetic tone can impact it. Furthermore, endocardial borders were challenging to

distinguish in some patients, particularly those who were obese or had poor echo windows. There was no follow-up to evaluate treatment efficacy or prognosis of CSF. ABPM data could not be established due to discomfort while sleeping, misleading readings throughout activity, and the incapacity to identify artefactual measurements. Finally, there were cost implications, even though the cost of devices is decreasing, and cost-benefit analyses have demonstrated that short-term costs are warranted by long-term savings.

Conclusion:

Non-dipper hypertensive patients were found to have a higher coronary slow flow with a higher TIMI frame count compared to dipper hypertensive patients.

Recommendations

It is recommended to increase the use of ABPM for hypertension diagnosis and management as it can detect blood pressure patterns not detectable by regular office BP measurements. Recognizing a dipper/non-dipper pattern in patients with hypertension can improve risk stratification and prevent premature adverse events. Further studies should investigate the impact of abnormal circadian blood pressure patterns on coronary blood flow.

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Conflict of interest:

The authors disclose all possible conflicts of interest, including financial and other relationships that can bias the results.

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العلاقة بين نمط ضغط الدم اليومي والتدفق التاجي البطيء

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المقدمة: قد ينخفض ضغط الدم ليلا بنسبة تزيد عن ١٠٪ في ضغط الدم الشرياني أثناء إيقاع الساعة البيولوجية بينما يكون الانخفاض إلى أقل من ١٠٪ في مرضي اخرين، يرتبط التدفق البطيء للشريان التاجي بمضاعفات خطيرة في القلب والأوعية الدموية ، ونقص تروية عضلة القلب ، وعدم انتظام ضربات القلب الخبيث ، ووفيات القلب والأوعية الدموية. لقد هدفنا إلى التحقيق في العلاقة بين نمط ضغط الدم اليومي وانحلال الخثرة في عدد إطارات احتشاء عضلة القلب، وهو مؤشر على بطء تدفق الشريان التاجي

الخلاصة: التدفق البطيء للشريان التاجي مرتبط مع ارتفاع عدد إطارات احتشاء عضلة القلب في المرضي اصحاب انخفاض ضغط الدم اقل من ١٠٪ ليلا.