



SIGNIFICANCE OF REVERSE BLOOD PRESSURE DIPPING IN PATIENTS WITH ISCHEMIC HEART DISEASE

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Abstract:

Introduction: In a healthy individual, Blood Pressure represents a circadian rhythm during the 24-hour period with levels highest while awake and fall during sleep. Hypertensive patients, who exhibit reverse BP immersion is exposed to a higher risk of developing diabetes and metabolic syndrome. The main objective of our study was to determine the blood pressure frequency, reverse dipping in ischemic coronary disease patients.

Methodology: This descriptive, cross-sectional study was conducted on the medical unit of the Pakistan Ordnance Factory (POF) Hospital Wah Cantt from 1st May 2025 to 30th October 2025 to determine the frequency of blood pressure, reverse immersion in patients with ischemic heart patients. A total of 130 patients having hypertension with IHD of age 40-80 years were selected. Patients with stable angina, diabetes, CLD and stroke and End-stage renal disease were excluded. All required data collected are based on continuous and categorical variables like 24 hours systolic mean ABPM and 24 hours diastolic mean ABPM, age, gender and blood pressure reverse dipping pattern.

Results: The mean age considered during the study was 58.23 ± 8.80 years, ranging between 40 to 80 years aged people. Most of the patients 84 (64.62%) were between 40 to 60 years of age. Out of 130 patients, 58 (44.62%) were male and 72 (55.38%) were females with male to female ratio 1:1.2. 24 hours systolic mean ABPM (mm Hg), 24 hours diastolic mean ABPM (mm Hg), midday systolic blood pressure, midday diastolic blood pressure, midnight systolic blood pressure and midnight diastolic blood pressure is 133.43 ± 13.53 , 91.25 ± 7.32 , 128.67 ± 10.44 , 87.98 ± 6.91 , 137.56 ± 14.29 and 93.51 ± 8.09 respectively. In the current study, frequency of blood pressure reverse dipping in ischemic heart disease was found in 44 (33.85%) patients.

Conclusion: This study revealed that the reverse dipping of blood pressure's frequency in patients with ischemic heart disease is quite high highlighting its clinical significance.

Keywords: Hypertension, Ischemic heart disease, Reverse dipping.

Introduction:

Hypertension is diagnosed when systolic blood pressure (SBP) reaches 140 mm Hg or diastolic blood pressure (DBP) reaches 90 mm Hg or higher, or if the individual is on antihypertensive drugs. Primary hypertension represents 90-95% of adult cases, while secondary hypertension accounts for 2-10% of cases. Worldwide, Croatia is thought to be among the countries with highest prevalence of hypertension by 2040, with expected increase in prevalence of approximately 7.7% and 4% in Pakistan and India¹. Similarly low income countries and male gender are expected to be more affected by hypertension in coming years¹. Hypertension is the main global health problem and significantly contributes to the burden of non-portable diseases. It is also the main cause of cardiovascular disease, chronic kidney and stroke disease. More than 25% of the adult population in the world suffers from hypertension and is expected to rise further in coming years². In the United States, approximately 34% of adults are affected. In Pakistan, a national survey found that nearly 18.9% of individuals aged 15 years and older had hypertension³. Global studies including 90 countries showed 31.5% of hypertension prevalence in low -income countries compared to 28.5% in high income countries^{4,5}. The increase in the prevalence of hypertension is particularly remarkable in developing countries where cardiovascular diseases occur at a younger age, contributing to approximately two -thirds of the deaths associated with hypertension. The study in Pakistan emphasized the urgent need for action due to the high level of hypertension in the population⁶. In addition to cardiovascular diseases, hypertension exists, and several behavioral and socio-demographic characteristics are considered to be associated with both⁷. Hypertension is often associated with cardiovascular disease and several behavioral and Sociodemo-demographic factors contribute to both conditions. Ischemic heart disease (IHD), which includes conditions such as coronary heart disease, cerebrovascular disease and rheumatic heart disease, remain the main cause of death around the world and cause approximately 17.9 million deaths every year. The severity of cardiovascular disease is not sufficient focus on Prevention of risk factors such as hypertension. Numerous factors linked to ischemic heart disease, such as obesity, high salt consumption, and elevated cholesterol levels, are also known to contribute to hypertension. Ambulatory blood pressure monitoring (ABPM) provides valuable insights into blood pressure patterns, including diurnal fluctuations and variability, and can help assess the long-term prognosis for hypertensive individuals. Studies have highlighted that hypertensive patients who exhibit reverse BP immersion is exposed to a higher risk of developing diabetes and metabolic syndrome⁸.

In a healthy individual, Blood Pressure represents a circadian rhythm during the 24-hour period with levels highest while awake and fall during sleep. Based on the percentage decline in nocturnal BP compared to daytime BP, individuals can be categorized into non-dipping (decline 0 to <10%), dipping (decline 10% to 20%), extreme dipping (decline >20%), and reverse dipping (decline <0%) patterns. The relationship between the pattern of reverse immersion of blood pressure and cardiovascular events was largely studied. Individuals with reverse immersion experience a significantly higher degree of cardiovascular mortality compared to those with other patterns of dipping blood pressure^{9,10,11}.

Reverse or inverted dipping refers to a condition in which nighttime blood pressure (BP) remains the same or increases relative to daytime BP, indicating a significant alteration in the usual circadian BP pattern. This phenomenon is often considered a harmful BP phenotype. Reverse dipping occurs when nighttime BP exceeds daytime levels, and studies estimate that around 6% of untreated individuals with nocturnal hypertension exhibit this pattern. In contrast, 13.5% of patients on antihypertensive medications were identified as reverse dippers, likely due to the timing of medication administration in the morning, which lowers the daytime-to-nighttime BP ratio. Research has indicated that reverse immersion may be a more significant predictor of cardiovascular (CV) risk compared to the non-

dipping. One study showed that reverse dippers had a higher incidence of adverse CV events after medium tracking 5.7 years, although CV results were associated with both reverse immersion and not immersion (17.6% vs. 9.5%)^{12,13}.

Multiple studies have been reported on reverse dipping in ischemic heart disease patients worldwide like China and Italy and their statistics are given as 31%, and 39% respectively^{14,15}. Studies have also revealed that reverse immersion of BP is associated with a greater probability of gap infarction and carotid plaque development, which can serve as a reliable predictor of coronary arteries (CAD). CAD is the main cause of cardiovascular mortality around the world. Hypertension is widely recognized as a significant risk factor for CAD^{16,17}. BP reverse immersion, with a higher medium night of SBP than a day, was previously categorized as part of "non-dipping" and considered as a risk factor for cardiovascular disease risk¹⁸. In addition, while the reduced Night immersion of BP has been identified as a predictor of cardiovascular risk, previous research suggests that certain circadian BP formulas can contribute to myocardial ischemia. There is currently no local study that explains the frequency between ischemic heart disease and reverse immersion. The reason for the current study was to determine the frequency of blood pressure reverse immersion in ischemic heart disease at the POF Wah Cantt Hospital. The results of this study will give the significance of reverse dipping and will be an important parameter for cardiovascular morbidity and mortality outcomes.

Methodology

This descriptive, prospective, cross-sectional study was conducted on the medical unit of the Pakistan Ordnance Factory (POF) Hospital Wah Cantt from 1st May 2025 to 30th October 2025 to determine the frequency of blood pressure, reverse immersion in patients with ischemic heart patients. Blood pressure (BP) is a reproducible circadian formula, which is usually lower at night than about 10-20% during the day, mostly due to endogenous neuroendocrine rhythms and other variables. Circadian patterns BP are classified as extreme immersion (Night/day ratio ≤ 0.8), immersion (0.8-1.0). Maintaining a level of reliability of 95 % and a 8 % error span was calculated sample size using the expected frequency of 31.0¹⁹.

After getting the ethical approval from the hospital ethical board (No. IRB/POFH/01-2025/MEDICINE/01) informed and written consent was taken from patients admitted in the medical ward of Pakistan Ordnance Factories hospital who full filed the inclusion criterion. All required data collected on the basis of continuous and categorical variables like 24 hours systolic mean ABPM and 24 hours diastolic mean ABPM, age, gender and blood pressure reverse dipping pattern as per Performa attached and obtained. The data was processed and analyzed using a statistical approach for social sciences (IBM SPSS version 25). Categorical variables such as gender sex and reverse BP have been described in frequencies and percentage, while continuous variables such as age, 24 -hour systolic diameter ABPM (mm Hg), 24 -hour diastolic diameter (mm Hg), noon systolic blood pressure, midnight systolic blood pressure and midnight diastolic blood pressure was described in terms of diameter and standard deviation.

Results:

The mean age considered during the study was 58.23 ± 8.80 years, ranging between 40 to 80 years old. Most patients 84 (64.62%) were 40 to 60 years, as shown in Table 1. Of the 130 patients were 58 (44.62%) men and 72 (55.38%) were women with a man on a woman 1: 1.2, as shown in Figure 1. 24 hours systolic diameter ABPM (mmHg), 24 hours diastolic average ABPM (mmHg), noon systolic blood pressure, noon diastolic blood pressure, midnight systolic blood pressure and midnight diastolic blood pressure is 133.43 ± 13.53 , 91.25 ± 7.32 , 128.67 ± 10.44 , 44 , 10.44 , 128.67 ± 10.44 , 128.67 ± 10.44 , 128.67 ± 10.44 , 128.67 ± 10.44 , 128.67 ± 10.44 , 128.67 ± 10.44 , 128.67 ± 10.44 , 87.98 ± 6.91 , 137.56 ± 14.29 and 93.51 ± 8.09 (table 2). In this study, the frequency of reverse immersion of blood pressure in ischemic heart disease was found in 44 (33.85%) (Figure 2). Table 3 and 4 show stratification of blood pressure with regard to age groups and gender

Table-1: Distribution of patients according to Age (n=130).

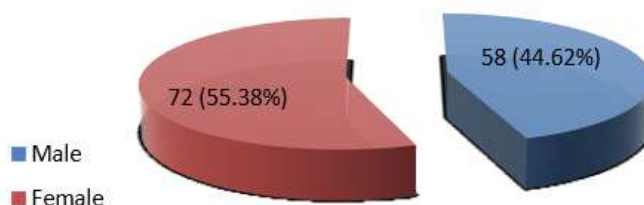
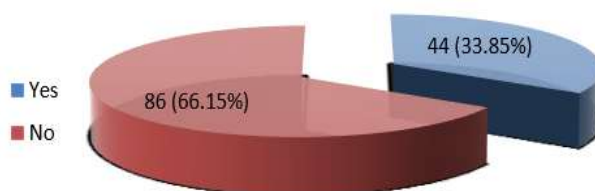
Age (in years)	No. of Patients	% age
40-60	84	64.62
61-80	46	35.38
Total	130	100.0

Table-2: Descriptive statistics of different variables**Table 3:** Stratification of blood pressure reverse dipping with respect to age groups.

Variables	Mean $\pm$ SD		
24 h-mean SBP, ABPM (mmHg)	133.43 $\pm$ 13.53		
24 h-mean DBP, ABPM (mmHg)	91.25 $\pm$ 7.32		
Midday SBP, (mmHg)	128.67 $\pm$ 10.44		
Midday DBP, (mmHg)	87.98 $\pm$ 6.91		
Midnight SBP, (mmHg)	137.56 $\pm$ 14.29		
Age (years)	Blood pressure reverse dipping		p-value
	Yes	No	
40-60	28	0.867	0.867
61-80	16	61-80	

Table 4: Stratification of blood pressure reverse dipping with respect to gender.

Gender	Blood pressure reverse dipping		p-value
	Yes	No	
Male	16	42	0.176
Female	28	44	

**Figure 1:** Distribution of patients according to gender (n=130).**Figure 2:** Prevalence of blood pressure reverse dipping in ischemic heart disease

Discussion:

In this study, the frequency of reverse immersion of blood pressure in ischemic heart disease was found in 44 (33.85%) patients. In a pioneering study published two decades ago, scientists examined the relationship between the night decline in BP and mortality in 1542 adult rural Japanese community after an average monitoring period of 5.1 years. Ohkubo and his colleagues²⁰ presented the first data on the prevalence of reverse immersion (RD) in the sample of the general population. The participants were grouped on the basis of a percentage reduction at night BP: (1) Extreme dippers (BP reduction > 20%); (2) Dippers (BP reduction > 10% and < 20%); (3) Non dippers (reduction of BP > 0% and < 10%); and (4) reverse dippers (night increase BP). The largest group was Dippers (67%), followed by

extreme dippers (15%) and Non dipper (13%). Those with RD tend to be older, more often men and had a higher level of smoking along with greater prevalence of cardiovascular diseases. Reverse dipping was found to be linked as an independent risk factor for atherosclerotic disease or lower limb ischemia in diabetic patients²¹. Among hypertensive patients, the likelihood of a dipping blood pressure pattern decreases with age and may peak around ages 54–57²². More than half of the reverse dippers were classified as isolated night hypertension because their BP values in the office and daily BP were within normal range.

Different authors observed racial differences in the size of the night fall of BP and distribution of the immersion/non-dipping status. In particular, black patients tend to experience a minor reduction in the average BP at night compared to other ethnic groups. There is evidence that BP changes are affected by seasonal changes at night particularly those in dippers²³. Pham et. Al recently stated that the prevalence of non -dippers was significantly higher in the stroke group compared to the stroke group ($p < 0.001$), with a similar BP rate not complicated among patients with ischemic and hemorrhagic stroke¹¹.

Conclusion

The prevalence of blood pressure reverse dipping in ischemic heart disease is quite high, hence we recommend that proper screening and monitoring of blood pressure reverse dipping in hypertensive ischemic heart disease should be done in order to reduce morbidity and mortality.

Conflict of interest: None

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