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Ambulatory Blood Pressure Monitoring Unmasks a High Prevalence of Hypertension in Kidney Transplant Recipients: A Prospective Cohort Study Comparing Clinic, Self-Measurement, and ABPM

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Abstract

Background

Hypertension is a major modifiable risk factor affecting graft and patient survival after kidney transplantation. However, the optimal method for its diagnosis remains uncertain. This study aimed to compare clinic blood pressure measurement (CBPM), self-blood pressure measurement (SBPM), and ambulatory blood pressure monitoring (ABPM) in kidney transplant recipients (KTRs).

Methods

We conducted a prospective longitudinal study including 115 KTRs followed at the Nephrology Department of Mustapha University Hospital (Algiers). Blood pressure was assessed using CBPM, SBPM, and 24-hour ABPM at 1, 3, 6, and 12 months post-transplantation. Hypertension was defined according to ESH/ESC 2013 guidelines. White-coat hypertension (WCH) and masked hypertension (MH) were defined based on discrepancies between CBPM and ABPM.

Results

The prevalence of hypertension increased over time when assessed by ABPM, from 7.8% at 1 month to 50.4% at 12 months. CBPM consistently underestimated the true prevalence. Masked hypertension was highly prevalent, representing 33.3%, 52.6%, 71.8%, and 60.3% of hypertensive patients at 1, 3, 6, and 12 months, respectively. White-coat hypertension was less frequent and decreased over time. A non-dipping pattern was commonly observed among hypertensive patients.

Conclusion

ABPM is a superior tool for diagnosing hypertension in KTRs, revealing a substantial burden of masked hypertension missed by conventional measurements. Its systematic use should be considered in routine follow-up.

1. Introduction

Hypertension (HTN) is one of the most common complications after kidney transplantation and represents a major modifiable risk factor for both graft dysfunction and cardiovascular morbidity and mortality [8, 9]. Accurate diagnosis and optimal management of HTN are therefore critical in this high-risk population.

However, blood pressure (BP) assessment in kidney transplant recipients (KTRs) remains challenging. Conventional clinic blood pressure measurement (CBPM) may not accurately reflect the true BP burden due to phenomena such as white-coat hypertension (WCH) and masked hypertension (MH). These discrepancies may lead to misclassification and inappropriate management.

Ambulatory blood pressure monitoring (ABPM) and self-blood pressure measurement (SBPM) have been proposed as more reliable alternatives [12]. ABPM, in particular, provides valuable information on circadian BP patterns, including nocturnal hypertension and non-dipping status, which are associated with adverse outcomes [5].

Despite these advantages, there is limited prospective data comparing CBPM, SBPM, and ABPM longitudinally in KTRs [10, 11].

The objective of this study was to prospectively compare these three methods for diagnosing hypertension and to determine the prevalence and evolution of WCH and MH during the first year following kidney transplantation.

2. Methods

2.1 Study Design and Population

This prospective, single-center cohort study included 115 adult kidney transplant recipients followed at the Nephrology Department of Mustapha University Hospital (Algiers). Patients were included consecutively after transplantation and followed for 12 months.

Inclusion criteria comprised adult patients (≥ 18 years) with a functioning graft. Exclusion criteria included graft loss within the first month, inability to perform BP monitoring, or incomplete follow-up data.

The study was conducted in accordance with the Declaration of Helsinki and approved by the local ethics committee. The study was reported in accordance with the STROBE guidelines for observational studies. All participants provided written informed consent.

All transplanted organs were obtained from voluntary donors in accordance with national regulations. No organs or tissues were obtained from prisoners. Transplantations were performed at Mustapha University Hospital (Algiers), through the Department of Nephrology, Dialysis and Kidney Transplantation.

2.2 Blood Pressure Measurements

Clinic Blood Pressure Measurement (CBPM)

BP was measured using a validated oscillometric device after a 5-minute rest in the seated position. Three measurements were taken, and the average of the last two was recorded. Measurements were performed on the arm without an arteriovenous fistula.

Self-Blood Pressure Measurement (SBPM)

Patients performed SBPM over three consecutive days, with three measurements in the morning and three in the evening. The average of all readings was calculated.

Ambulatory Blood Pressure Monitoring (ABPM)

Twenty-four-hour ABPM was performed using a validated device (Spacelabs 90217). BP measurements were recorded every 15 minutes during the day and every 30 minutes at night. Recordings were considered valid if at least 70% of measurements were successful.

2.3 Definitions

Hypertension was defined according to the ESH/ESC 2013 guidelines, which were the current reference at the time of study design and data collection.

Although more recent guidelines are available, we used the 2013 ESH/ESC definitions to ensure consistency with the study protocol and longitudinal comparisons.

White-coat hypertension was defined as CBPM ≥ 140/90 mmHg with daytime ABPM < 135/85 mmHg.

Masked hypertension was defined as CBPM < 140/90 mmHg with daytime ABPM ≥ 135/85 mmHg.

Nocturnal BP patterns were categorized as dipper or non-dipper based on the nocturnal decline in BP.

2.4 Statistical Analysis

Statistical analyses were performed using SPSS version 20.0 and R software. Continuous variables were expressed as mean ± standard deviation or median (interquartile range), as appropriate. Categorical variables were expressed as percentages.

Comparisons between groups were performed using the chi-square or Fisher's exact test for categorical variables. A p-value < 0.05 was considered statistically significant.

3. Results

3.1 Patient Characteristics

The study included 115 kidney transplant recipients. Baseline characteristics, including age, sex, donor type, and immunosuppressive therapy, are summarized in Table 1.

Table 1
Prevalence of hypertension at 12 months according to measurement method (N = 115)

Measurement Method	Hypertension Definition	Hypertensive Patients (n)	Prevalence (%)
Clinic BP (CBPM)	BP ≥ 140/90 mmHg	40	34.8
Self-Measured BP (SBPM)	BP ≥ 135/85 mmHg	48	41.7
Ambulatory BP (ABPM)	24-hour average ≥ 130/80 mmHg	58	50.4

3.2 Prevalence of Hypertension According to Measurement Method

The prevalence of hypertension increased over time when assessed by ABPM, reaching 50.4% at 12 months post-transplantation. In contrast, CBPM consistently underestimated hypertension prevalence across all time points.

3.3 Prevalence of White-Coat and Masked Hypertension

Masked hypertension was highly prevalent and increased significantly during follow-up (Table 2). In contrast, white-coat hypertension remained relatively low and decreased over time. Among hypertensive patients, masked hypertension represented the predominant phenotype across all time points (Table 3).

Table 2
Global prevalence of blood pressure phenotypes (N = 115)

BP Phenotype	1 Month	3 Months	6 Months	12 Months
Masked Hypertension	3 (2.6%)	10 (8.7%)	28 (24.3%)	35 (30.4%)
White-Coat Hypertension	18 (15.7%)	13 (11.3%)	14 (12.2%)	14 (12.2%)
Percentages are calculated based on the total study population (N = 115).				

Table 3
Distribution of hypertension phenotypes among hypertensive patients only

BP Phenotype	1 Month (n = 9)	3 Months (n = 19)	6 Months (n = 39)	12 Months (n = 58)
Masked Hypertension	3 (33.3%)	10 (52.6%)	28 (71.8%)	35 (60.3%)
Sustained Hypertension	6 (66.7%)	9 (47.4%)	11 (28.2%)	23 (39.7%)
Percentages are calculated within the hypertensive population at each time point.				

3.4 Nocturnal Blood Pressure Profile

A high proportion of hypertensive patients exhibited a non-dipping pattern, indicating abnormal circadian BP regulation. The evolution of blood pressure phenotypes over time is illustrated in Fig. 1.

3.5 Therapeutic Implications

Patients diagnosed with hypertension by ABPM required a higher number of antihypertensive medications compared to those diagnosed by CBPM alone.

4. Discussion

4.1 Main Findings

This prospective study demonstrates that CBPM significantly underestimates the true prevalence of hypertension in KTRs. ABPM revealed a marked increase in hypertension prevalence over time, reaching more than 50% at one year post-transplantation.

The most notable finding is the high prevalence of masked hypertension, affecting more than half of patients at 12 months. This highlights the limitations of relying solely on clinic measurements.

4.2 Comparison with Existing Literature

Our findings are consistent with previous studies reporting a high prevalence of masked hypertension in KTRs and its association with adverse renal and cardiovascular outcomes [1, 7]. The prevalence of white-coat hypertension observed in our cohort is also consistent with published data [2].

4.3 Clinical Implications

These results support the systematic use of ABPM in the follow-up of kidney transplant recipients [6]. Early detection of masked hypertension may allow timely therapeutic intervention and improve long-term outcomes. These findings suggest that a substantial proportion of transplant recipients may remain undertreated if ABPM is not routinely implemented. Calcineurin inhibitor-related mechanisms may further contribute to hypertension burden in this population [3, 4].

4.4 Strengths and Limitations

The strengths of this study include its prospective design and longitudinal follow-up. Limitations include its single-center nature and the lack of long-term outcome data.

5. Conclusion

Masked hypertension is highly prevalent and frequently missed by conventional clinic measurements in kidney transplant recipients. ABPM provides a more accurate assessment of blood pressure and should be integrated into routine clinical practice.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and approved by the local ethics committee of Mustapha University Hospital. Written informed consent was obtained from all participants.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

MR contributed to study conception, data collection, analysis, and manuscript drafting. All authors contributed to manuscript revision and approved the final version.

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Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Figures

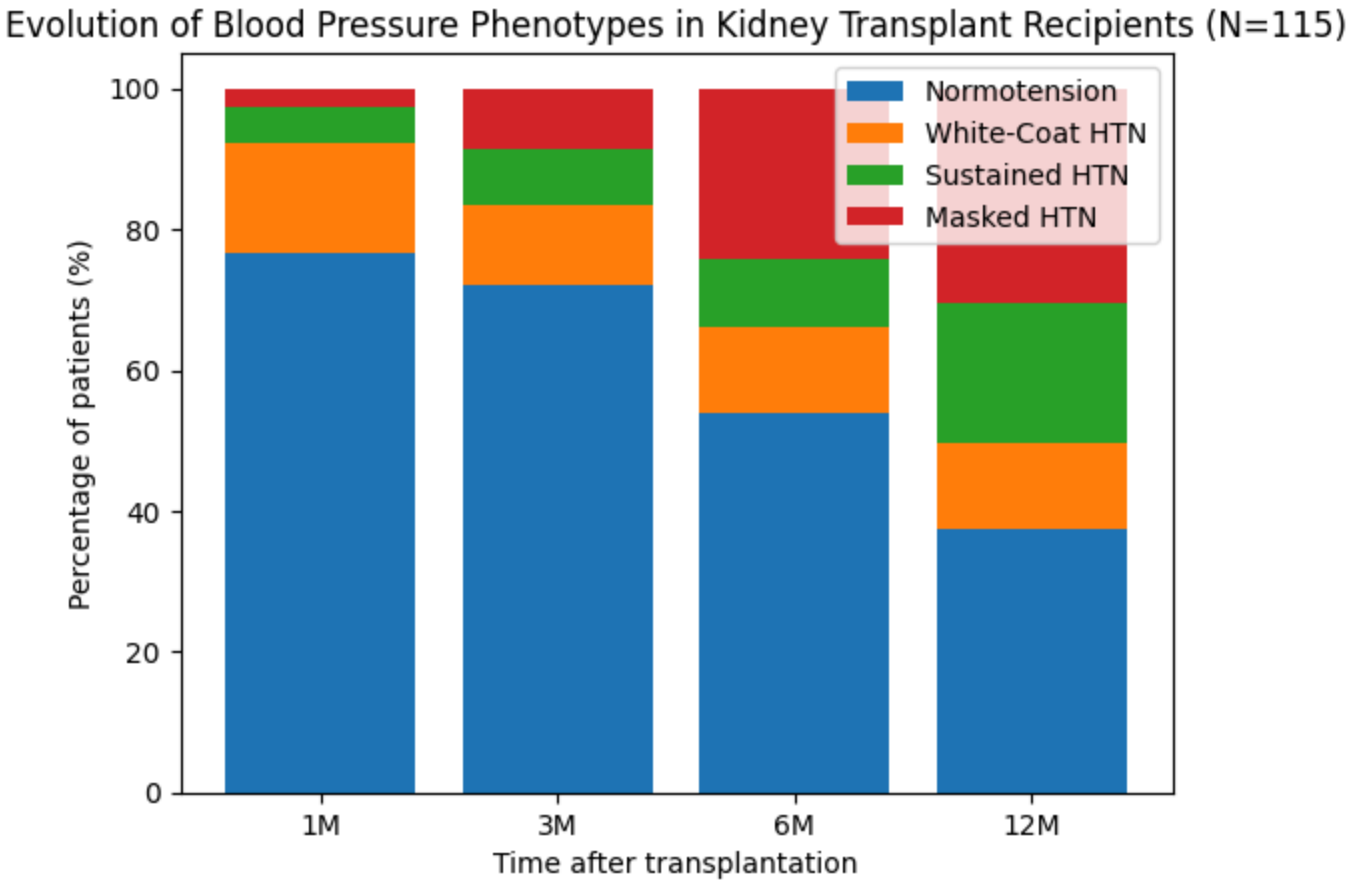


Figure 1

Evolution of blood pressure phenotypes over time.