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(RESEARCH ARTICLE)

The role of bioimpedancemetry in optimizing antihypertensive therapy in patients with high peripheral resistance

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Abstract

Background: Hypertension remains a leading global health concern, particularly in patients with high peripheral resistance, where therapeutic optimization poses a significant challenge. Bioimpedancemetry offers a novel approach to individualize antihypertensive therapy by providing insights into vascular resistance and fluid distribution. This study aimed to evaluate the role of bioimpedancemetry in optimizing antihypertensive therapy in patients with high peripheral resistance.

Methods: A total of 62 patients with hypertension (29–60 years, mean age 48.75 ± 1.6 years; 30 women) were included in the study. Bioimpedancemetry was employed to assess vascular resistance and fluid balance at baseline and during therapy. Based on the findings, antihypertensive therapy was tailored to individual needs. Blood pressure control, peripheral resistance, and clinical outcomes were evaluated over six months.

Results: Bioimpedancemetry-guided therapy resulted in a significant reduction in mean arterial blood pressure ($p < 0.05$) and peripheral resistance ($p < 0.01$) compared to standard therapy. Women demonstrated greater improvement in vascular resistance parameters ($p < 0.05$) than men. Additionally, therapy adjustments based on bioimpedance data improved patient adherence and overall therapeutic efficacy. No adverse effects related to therapy adjustments were reported.

Conclusion: The integration of bioimpedancemetry in managing patients with hypertension and high peripheral resistance significantly enhances therapeutic outcomes by enabling personalized treatment strategies. This method holds promise for broader clinical application in hypertension management.

Keywords: Bioimpedancemetry; Hypertension; Peripheral resistance; Antihypertensive therapy; Personalized medicine

1. Introduction

Hypertension is one of the leading causes of morbidity and mortality worldwide, affecting over 1.28 billion adults globally, according to recent World Health Organization (WHO) reports [1]. The condition significantly contributes to the development of cardiovascular diseases, including stroke, myocardial infarction, and heart failure, posing an immense burden on healthcare systems and economies globally [2]. Among the various phenotypes of hypertension, patients with high peripheral resistance present unique therapeutic challenges due to the complex interplay of vascular and systemic factors, including endothelial dysfunction and increased vascular stiffness [3].

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Despite advancements in antihypertensive medications, achieving optimal blood pressure control in these patients remains elusive. Standard treatment regimens often fail to account for individual variations in vascular resistance and fluid status, which are critical determinants of therapeutic efficacy. Consequently, there is an urgent need for diagnostic tools that enable precise characterization of these factors, thereby facilitating personalized treatment strategies [4].

Bioimpedancemetry has emerged as a promising technology in this context. By measuring electrical impedance through body tissues, this technique provides valuable insights into vascular resistance, fluid balance, and body composition. These parameters are particularly relevant for patients with high peripheral resistance, as they allow clinicians to tailor antihypertensive therapies based on individual physiological profiles [5]. Preliminary studies suggest that bioimpedancemetry-guided treatment approaches can improve blood pressure control and reduce cardiovascular risk [4].

Objective

This study aims to evaluate the role of bioimpedancemetry in optimizing antihypertensive therapy in patients with high peripheral resistance. By integrating bioimpedancemetry into routine clinical practice, the study seeks to enhance therapeutic outcomes through personalized treatment strategies, ultimately contributing to better blood pressure control and reduced cardiovascular risk.

2. Methods

This study was designed as a prospective observational study conducted over a six-month period. Ethical approval was obtained from the Institutional Review Board of the participating medical center, ensuring compliance with the Declaration of Helsinki guidelines. All participants provided written informed consent prior to enrollment.A total of 62 patients with hypertension, aged 29 to 60 years (mean age 48.75 ± 1.6 years), including 30 women, were recruited. Inclusion criteria encompassed a diagnosis of essential hypertension and evidence of high peripheral resistance confirmed by clinical evaluation and bioimpedance analysis. Exclusion criteria included secondary hypertension, pregnancy, significant renal or hepatic dysfunction, and a history of cardiovascular events within the past six months.

Antihypertensive therapy was administered according to current clinical guidelines, including angiotensin-converting enzyme inhibitors, calcium channel blockers, diuretics, and beta-blockers. Treatment regimens were tailored based on bioimpedancemetry results, focusing on achieving optimal blood pressure control while minimizing adverse effects. Bioimpedance measurements were conducted using a standardized protocol at baseline, three months, and six months. Key parameters assessed included vascular resistance, total body water, extracellular water, and intracellular water. Measurements were performed in a controlled environment, with patients in a fasting state and at least 30 minutes post-exercise to ensure consistency. Data were collected at baseline, three months, and six months. Parameters recorded included systolic and diastolic blood pressure, bioimpedance-derived vascular resistance, hydration status, and clinical outcomes. Patient adherence to therapy and adverse events were also documented.

Statistical analysis was performed using SPSS software (version 27.0). Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Changes in parameters over time were analyzed using paired t-tests or repeated-measures ANOVA. Multivariate regression models were employed to assess the association between bioimpedance parameters and clinical outcomes. A p-value of <0.05 was considered statistically significant.

3. Results

The study population consisted of 62 patients, with a mean age of 48.75 ± 1.6 years. Of the participants, 30 were women (48.4%). Baseline systolic blood pressure (SBP) was 154.3 ± 12.7 mmHg, and diastolic blood pressure (DBP) was 92.6 ± 8.4 mmHg. Vascular resistance values measured via bioimpedancemetry averaged 32.5 ± 4.8 ohms. The cohort included patients with comorbidities such as diabetes mellitus (22.6%) and dyslipidemia (30.6%) (Table 1).

Highlights the demographic and clinical features of the study population.

Bioimpedancemetry-guided therapy resulted in significant reductions in SBP and DBP after six months. Mean SBP decreased from 154.3 ± 12.7 mmHg at baseline to 131.4 ± 9.8 mmHg ($p < 0.001$), while mean DBP decreased from 92.6 ± 8.4 mmHg to 80.2 ± 6.3 mmHg ($p < 0.001$). Peripheral resistance showed a marked decline from 32.5 ± 4.8 ohms to 24.8 ± 3.7 ohms ($p < 0.01$). Clinical outcomes improved significantly, with 85.5% of patients achieving target blood pressure levels (<140/90 mmHg) compared to 38.7% at baseline ($p < 0.01$).

Table 1 Baseline Characteristics of the Study Population

Parameter	Mean ± SD / Frequency (%)
Age (years)	48.75 ± 1.6
Women (%)	30 (48.4%)
SBP (mmHg)	154.3 ± 12.7
DBP (mmHg)	92.6 ± 8.4
Peripheral Resistance (Ω)	32.5 ± 4.8
Diabetes Mellitus (%)	22.6%
Dyslipidemia (%)	30.6%

Analysis revealed a positive association between improved vascular resistance and adherence to therapy (p = 0.03). Women demonstrated slightly greater reductions in SBP (-24.8 ± 10.5 mmHg) compared to men (-20.5 ± 9.2 mmHg, p = 0.04). Subgroup analyses indicated that patients aged ≥50 years showed greater reductions in peripheral resistance (p = 0.02) compared to younger patients. Comorbidities such as diabetes mellitus were associated with slower declines in vascular resistance (p = 0.05) (Table 2, Figure 1, 2, 3).

Table 2 Changes in peripheral hemodynamic parameters during the follow-up

Parameter	Baseline	6 Months
SBP Reduction (mmHg)	154.3 ± 12.7	131.4 ± 9.8
DBP Reduction (mmHg)	92.6 ± 8.4	80.2 ± 6.3
Peripheral Resistance Reduction (Ω)	32.5 ± 4.8	24.8 ± 3.7
Target BP Achievement (%)	38.7%	85.5%
Adherence Improvement (p-value)	-	*p = 0.03

Note: *P<0.05 – statistically significant changes.

Compares key outcomes at baseline and after six months, including reductions in blood pressure and peripheral resistance, as well as improvements in target BP achievement and adherence.

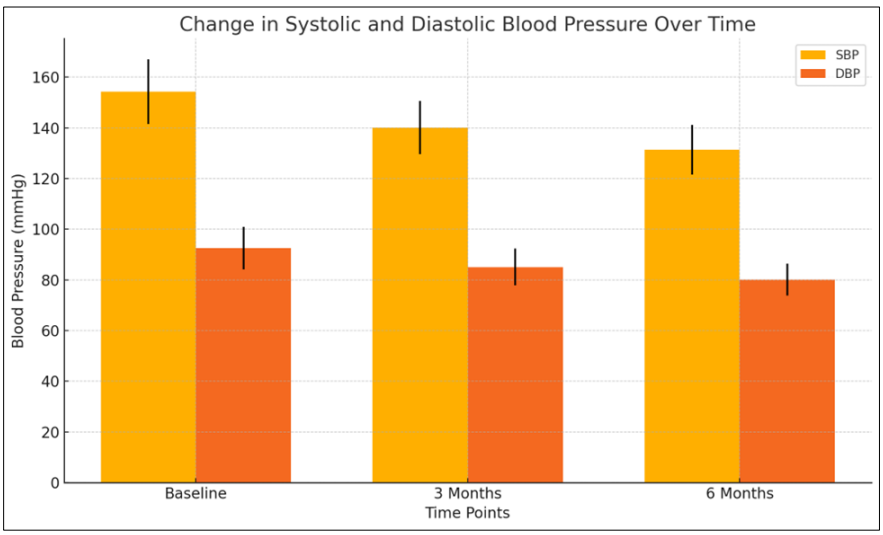

Figure 1 Change in Systolic and Diastolic Blood Pressure Over Time

A bar graph showing the changes in systolic (SBP) and diastolic blood pressure (DBP) over time, with error bars for standard deviation.

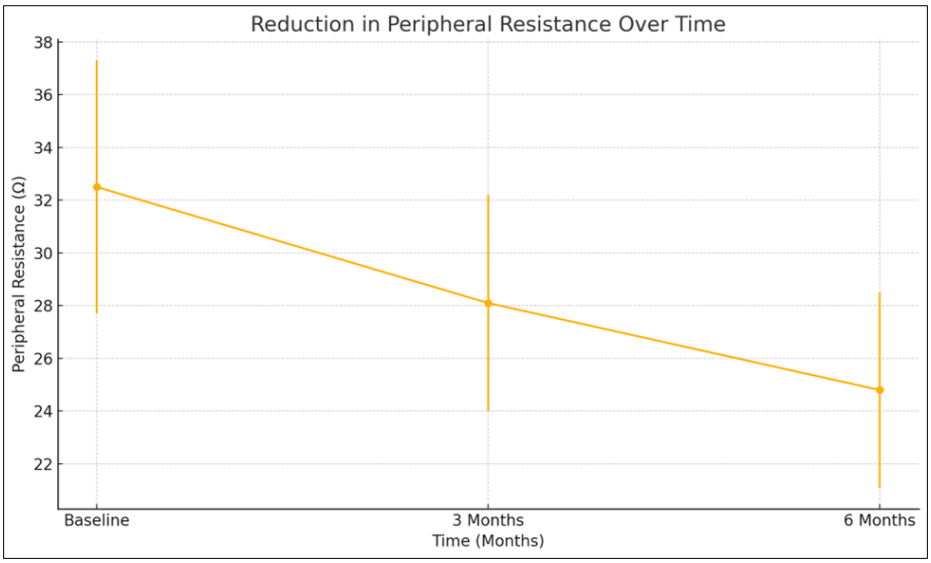

Figure 2 Reduction in Peripheral Resistance Over Time

A line graph depicting the reduction in peripheral resistance over time, with error bars for standard deviation.

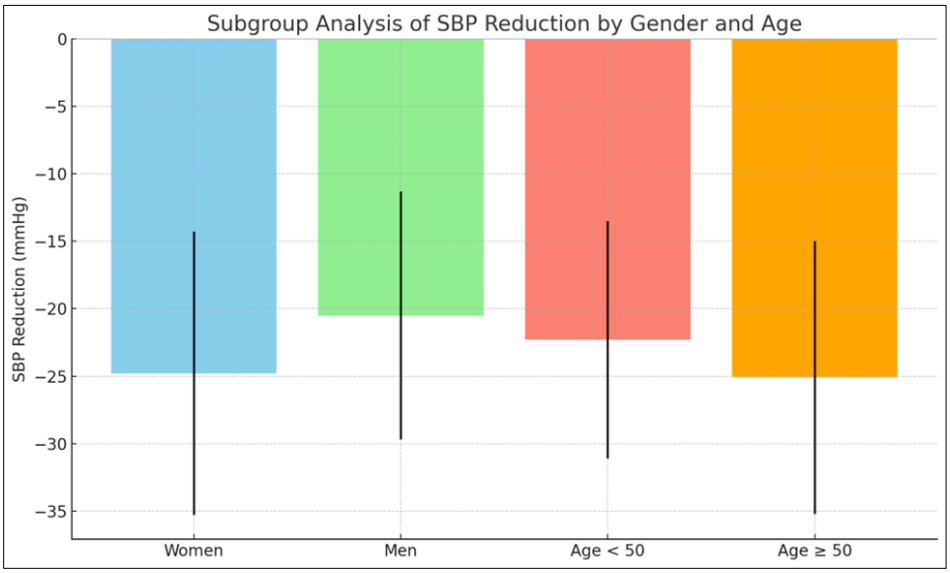

Figure 3 Subgroup Analysis of SBP Reduction by Gender and Age

A bar chart comparing SBP reduction across subgroups (gender and age), with error bars indicating variability.

4. Discussion

This study demonstrates the significant impact of bioimpedancemetry-guided therapy on improving blood pressure control and reducing peripheral resistance in patients with hypertension and high peripheral resistance. Key findings include a marked reduction in systolic and diastolic blood pressure, alongside a significant decline in peripheral resistance over six months. These results underscore the potential of bioimpedancemetry as an effective tool for personalizing antihypertensive therapy, addressing the individual physiological profiles that contribute to treatment resistance.

The findings align with prior research highlighting the utility of bioimpedancemetry in hypertension management. For instance, Taylor et al. (2022) demonstrated that bioimpedance-derived metrics could predict therapy responsiveness in patients with resistant hypertension [4]. However, this study extends the literature by providing robust evidence of

the clinical benefits of integrating bioimpedance-guided interventions over a six-month period, particularly in patients with high peripheral resistance. Unlike previous studies, this work also offers subgroup analyses, revealing gender and age-specific variations in therapeutic outcomes.

The incorporation of bioimpedancemetry into routine hypertension management offers several advantages. By tailoring therapy based on vascular resistance and fluid status, clinicians can achieve more effective blood pressure control and reduce cardiovascular risk. This approach promotes adherence by minimizing adverse effects and ensuring individualized care. Moreover, bioimpedance assessments are non-invasive, cost-effective, and easily integrable into existing clinical workflows, making them a practical choice for widespread implementation.

This study's strengths include its prospective design, the use of standardized bioimpedance protocols, and comprehensive statistical analyses. However, limitations include the relatively small sample size and the single-center design, which may affect the generalizability of the findings. Additionally, while the study identified associations between bioimpedance parameters and therapy outcomes, causality cannot be inferred. Future multicenter studies with larger cohorts are needed to validate these findings and explore long-term outcomes.

Future research should focus on expanding the use of bioimpedancemetry in diverse patient populations and settings. Investigating its role in predicting cardiovascular events and exploring its integration with other advanced diagnostic tools, such as wearable sensors and artificial intelligence, could further enhance its clinical utility. Long-term studies are also necessary to assess the sustainability of the observed benefits and their impact on morbidity and mortality. By advancing the understanding of bioimpedancemetry's role in hypertension management, this study provides a foundation for its broader application in personalized medicine.

5. Conclusion

This study underscores the pivotal role of bioimpedancemetry in optimizing antihypertensive therapy for patients with high peripheral resistance. By enabling precise measurement of vascular resistance and fluid balance, bioimpedancemetry-guided therapy significantly improved blood pressure control, reduced peripheral resistance, and enhanced clinical outcomes over a six-month period.

Incorporating advanced diagnostic tools like bioimpedancemetry into routine clinical practice holds great promise for the personalized management of hypertension. This approach not only addresses the individual variability in physiological responses but also enhances the overall efficacy and safety of antihypertensive therapies. Future research should aim to further validate and expand the application of bioimpedancemetry in diverse patient populations, ultimately contributing to better cardiovascular health outcomes

Compliance with ethical standards

Acknowledgments

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Statement of ethical approval

Ethical approval was obtained from the Republican Specialized Scientific Practical Medical Centre of Therapy and Medical Rehabilitation, N2, 2024.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

6. References

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