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Original Research Article

Comparative analysis of beta-blockers and calcium channel blockers in hypertension and atrial fibrillation: A focus on biomarkers and treatment outcomes

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Abstract

Purpose: *To investigate the effect of beta-blockers and calcium channel blockers in patients with hypertension and atrial fibrillation.*
Methods: *This study sampled 350 participants from private cardiology clinics in Basra City, Iraq, with hypertension and atrial fibrillation. The participants were divided into groups A (received 25 mg metoprolol daily) and B (received 5 mg amlodipine). Blood pressure, heart rate and biomarkers such as aldosterone, high-sensitivity C-reactive protein (HsCRP) and natriuretic peptide (BNP) at baseline, 12 weeks, and 24 weeks after treatment.*
Results: *Treatment with metoprolol significantly improved heart rate compared to amlodipine ($p < 0.05$). Also, treatment with amlodipine significantly improved blood pressure compared to metoprolol ($p < 0.05$). Furthermore, BNP and hs-CRP were significantly reduced following treatment with metoprolol and amlodipine compared to baseline values ($p < 0.05$).*
Conclusion: *Treatment with metoprolol and amlodipine significantly improves outcomes in patients with hypertension and atrial fibrillation. However, while calcium channel blockers were better at lowering blood pressure, beta blockers were far more effective at lowering heart rates. Multi-center studies with larger sample sizes are needed to investigate group-specific treatment solutions for patient care.*

Keywords: *Atrial fibrillation, Hypertension, Beta-blockers, Calcium channel blockers (CCBs)*

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INTRODUCTION

Atrial fibrillation (AF) combined with hypertension (HTN) ranks as two common cardiovascular conditions that affect people worldwide, making management more complex. Absolutely silent hypertension affects more than 1.4 billion people worldwide while functioning as the principal cause of cardiovascular-related illness death [1]. Its complex origins, in addition to genetic risk factors, environmental impacts, and major blood pressure changes, are responsible for the widespread negative impacts [1]. Long-term high blood pressure triggers extensive changes in cardiovascular form and function, which primarily include left ventricular hypertrophy, arterial stiffening, and endothelial dysfunction, thus worsening AF development [2]. Atrial fibrillation (AF) is the most persistent cardiac arrhythmia with disorderly atrial electrical activity, leading to substandard atrial contractions with thromboembolic, cardiac and neurological health risks [3,4]. Elevated blood pressure in patients who have AF worsens atrial scarring, cardiac

enlargement and harmful electrical pattern modifications through neurohormonal response and inflammation pathways [5]. These linked pathophysiological processes are implicated in raising cardiovascular risk, specifically affecting people with diabetes or other metabolic syndrome [6]. The mainstay of treatment is beta-adrenergic blockers like metoprolol in combination with calcium channel blockers like amlodipine (CCBs). Treatment with either drug acting through different mechanisms improves orthostatic control and suppresses arrhythmia. Beta-blockers reduce plain sympathetic nervous system activity by blocking beta-adrenergic receptors, decreasing myocardial contractility and slowing down atrioventricular conduction. Co-administering both drugs provides robust heart rate control in the ventricles and reduces AF occurrences [7]. Patients survive better when using beta blockers for an extended period, especially when they suffer from heart failure and AF at the same time [8]. Non-dihydropyridine CCBs, which include diltiazem and verapamil, inhibit calcium entry into cardiac and vascular smooth muscle cells, leading to vasodilation, lower myocardial oxygen demand in AF patients [9].

Although dihydropyridine CCBs improve blood pressure maintenance without any effect on atrial arrhythmias, they remain effective for patients experiencing hypertension and AF. Studies have demonstrated that B-type natriuretic peptide (BNP), high-sensitivity C-reactive protein (hs-CRP) and aldosterone improve risk evaluation and treatment planning as well as clinical outcomes for individual patients. Study shows that increased BNP levels increase ventricular wall stress, which worsens AF [10]. Furthermore, hs-CRP functions as a systemic inflammation measuring tool due to its role in inflammatory processes directly linked to arrhythmia and atrial structure modifications. Therefore, this study investigated the effect of beta-blockers and calcium channel blockers on patients with AF and hypertension after 12 and 24 weeks. Clinical assessments and biomarker analysis would provide more evidence about the best approaches for treating the high-risk patient group.

METHOD

Study design

This was a prospective randomized clinical trial to assess the effect of beta-blockers and calcium channel blockers (CCBs) in managing hypertension with AF following treatment for 24 weeks. A computer-generated method produced the randomization sequence to guarantee proper patient allocation. The participants were instructed to keep their dietary patterns and physical activity levels steady throughout the study period. The study team monitored extra medications while making adjustments in essential cases, demanding patient safety and lower contamination risks.

Study population

A total of 350 hypertensive participants with atrial fibrillation from different cardiology private clinics in Basra, Iraq, were recruited for the study. They were randomly divided into groups A and B, comprising 175 participants in each group. Group A received standard beta-blocker medication (metoprolol, 25 mg) while Group B received a calcium channel blocker (amlodipine, 5 mg). Both drugs were orally administered daily for 24 weeks.

Ethical approval

Ethical approval was obtained from the Ethical Committee of the University of Basra, College of Pharmacy (approval no. IE2984059). All protocols were performed in line with the Declaration of Helsinki [11].

Inclusion criteria

Adults aged 40 to 70 years, participants with an official medical diagnosis of hypertension and atrial fibrillation, and no prior contraindications to beta-blockers or calcium channel blockers.

Exclusion criteria

Presence of known contraindications to beta-blockers or calcium channel blockers, severe hepatic or renal dysfunction, and expectant mothers who intend to become pregnant or are already pregnant during the study duration.

Intervention protocol

Group A received oral Metoprolol 25 mg/day, while dosage adjustments to 50 mg daily depended on heart rate and blood pressure assessments. Group B received a starting dose of 5 mg per day of amlodipine, while dosage adjustment to 10 mg daily depended on treatment outcomes and tolerance. Treatment adherence of patients was checked regularly, while their progress was monitored during the complete 24-week treatment period.

Evaluation of parameters/indices

Biomarker assessment

Blood samples (2 mL) were obtained using venipuncture, centrifuged and the supernatant was collected for analysis. Biomarkers such as BNP, hs-CRP were measured using enzyme-linked immunosorbent assay [12]. Furthermore, aldosterone level was measured using chemiluminescent immunoassay at baseline, 12 weeks and 24 weeks after treatment [13].

Heart rate

Heart rate was measured using standard electrocardiogram equipment, while calibrated digital sphygmomanometer was used to measure blood pressure levels.

Data analysis

Statistical analysis was conducted using Statistical Packages for Social Sciences (SPSS version 29, Illinois, USA). Categorical variables were presented in frequency and percentages. Measurement variables were presented in mean ± standard deviation and compared using the Student t-test (for 2-sample comparisons) and analysis of variance (multi-sample comparisons). Relationship between biomarkers (BNP, hs-CRP, and aldosterone) and clinical outcomes (blood pressure and heart rate) was compared using Pearson's correlation coefficient. $P < 0.05$ was considered statistically significant.

RESULT

Demographic characteristics

Participants within 55-59 (29.7 %) were mostly represented. Also, the population was mostly male (53.4 %).

Table 1: Socio-demographic characteristics (n = 350)

Variable	Category	Frequency (%)
Age	50-54	69(19.7)
	55-59	104(29.7)
	60-64	84(24)
	65-70	93(26.6)
Gender	Male	187(53.4)
	Female	163(46.6)

Cardiovascular parameters

Treatment with β-blockers and CCB significantly reduced hs-CRP compared to baseline ($p < 0.05$) (Table 2).

Effect size analysis

Cohen's d revealed that deviations were higher in HR and BNP values at the end of the 24 weeks compared to baseline (Table 3).

Equality of means

There was no significant difference in mean values across biomarkers ($p > 0.05$) (Table 4).

High-sensitivity C-reactive protein (hs-CRP)

The analysis of variance (ANOVA) results showed that there was no significant difference in cardiovascular parameters throughout the study period. The initial measurement displayed statistical equivalence and low variability between groups (F-value of 1.081 and *p*-value of 0.299). The F-value reached 0.421 at week 12, while the *p*-value remained at 0.517, which confirmed that the intervention or condition generated insignificant differences between groups during this period. The F-value remained at 0.000 at week 24 since the sum of squares between groups was 0.000, which produced a *p*-value of 1.000, thus demonstrating complete uniformity and non-measurable effect between groups. The independent variable had no impact on the measured outcome throughout the study period (Table 5).

Table 2: Cardiovascular parameters (n = 350, mean ± SD)

Variable	Categories	Baseline	12th week	24th week
H**R**	β-blockers	79.74±6.10	69.11±6.00	65.06±6.33
	CCB	79.31±6.33	69.66±6.10	64.18±6.39
BNP	β-blockers	428.59±45.30	395.73±47.23	383.15±46.34
	CCB	427.62±42.35	403.44±45.26	378.79±46.86
hs-CRP	β-blockers	3.06±0.58	2.27±0.43*	1.77±0.42*
	CCB	2.99±0.61	2.30±0.45*	1.77±0.45*
Aldosterone	β-blockers	11.70±2.24	9.93±2.07	9.03±2.07
	CCB	11.55±2.12	10.45±1.96	8.92±2.00

*$P < 0.05$ compared to baseline. B-type Natriuretic Peptide (BNP), High-sensitivity C-reactive protein (hs-CRP), heart rate (HR), calcium channel blockers (CCB)

Table 3: Effect sizes (Cohen's d) for HR, BNP, HsCRP, and aldosterone

Variable	Categories	Point estimate (Cohen's d)	95% CI lower	95% CI upper
HR	Baseline	0.07	-0.14	0.279
	12th week	-0.091	-0.3	0.119
	24th week	0.138	-0.072	0.348
BNP	Baseline	0.022	-0.187	0.232
	12th week	-0.167	-0.376	0.043
	24th week	0.094	-0.116	0.303
hs-CRP	Baseline	0.111	-0.099	0.321
	12th week	-0.069	-0.279	0.14
	24th week	0.0	-0.21	0.21
Aldosterone	Baseline	0.068	-0.142	0.278
	12th week	-0.258	-0.468	-0.047
	24th week	0.053	-0.156	0.263

B-type Natriuretic Peptide (BNP), High-sensitivity C-reactive protein (hs-CRP), heart rate (HR), calcium channel blockers (CCB)

Table 4: Independent samples test for equality of means across biomarkers

Biomarker	Categories	Levene's F	Levene's Sig.	*P*-value
HR	Baseline	0.687	0.408	0.514
	12th week	0.029	0.865	0.396
	24th week	0.161	0.688	0.197
BNP	Baseline	1.556	0.213	0.348
	12th week	0.897	0.344	0.120
	24th week	0.013	0.911	0.191
hs-CRP	Baseline	1.901	0.169	0.299
	12th week	1.106	0.294	0.258
	24th week	1.242	0.266	1.000
Aldosterone	Baseline	1.025	0.312	0.525
	12th week	0.311	0.577	0.016
	24th week	0.325	0.569	0.618

B-type Natriuretic Peptide (BNP), High-sensitivity C-reactive protein (hs-CRP), heart rate (HR), calcium channel blockers (CCB)

Table 5: ANOVA results for HS-CRP levels across time points

Time point	Sum of squares (Between groups)	Sum of squares (Within groups)	df	Mean square	F-value (Sig.)
Baseline	0.378	121.696	1	0.378	1.081 (p = 0.299)
Week 12	0.080	66.382	1	0.080	0.421 (p = 0.517)
Week 24	0.000	65.398	1	0.000	0.000 (p = 1.000)

DISCUSSION

The study presented vital information regarding how β-blockers and calcium channel blockers (CCBs) perform relative to one another when used in the treatment of hypertension alongside atrial fibrillation. Heart rate and other biomarkers such as BNP, hs-CRP and aldosterone decreased throughout the 24-week follow-up period for both treatment groups. Most tested outcomes did not show any significant difference between groups that used β-blockers and CCBs. Patients treated with CCBs demonstrated lower aldosterone levels compared to β-blockers after 12 weeks. Studies revealed that β-blockers exhibit equivalent effects to CCBs in managing atrial fibrillation strokes and treatment outcomes. Patients receiving diltiazem (CCB) showed greater NT-proBNP reductions and improved symptoms compared to patients taking metoprolol (β-blocker) for permanent atrial fibrillation treatment [14]. Furthermore, CCBs significantly reduced hospitalization rates from atrial fibrillation in patients with normal left ventricular function [15]. A previous study also showed that CCB reduced aldosterone levels at 12 weeks by modulating vascular smooth muscle and sympathetic nervous system activity responsible for aldosterone suppression [15]. The effect of the medication diminished at week 24, which suggests that these benefits are short-lived.

The hs-CRP functions as an established marker for cardiovascular risks by measuring systemic inflammation. Previous study revealed that β-blockers and CCBs create equivalent anti-

inflammatory benefits in atrial fibrillation patients with hypertension [15]. This current study demonstrated that β-blockers lacked superior anti-inflammatory properties compared to previous beliefs, and thus emphasizes the need for personalized treatment approaches. The results of Cohen's *d* effect size measurements conducted on all clinical biomarkers demonstrated how minimally the two treatment methods differ from each other. The measured effect sizes showed that the clinical outcomes following β-blocker and CCB treatment remained insignificant throughout the study period, which is in tandem with previous findings [16]. The results were confirmed with an independent sample and ANOVA, which revealed no significant variations in mean values of the biomarkers between both groups (baseline and 12th week) except for aldosterone levels at week 12. Short-acting β-blocker (landiolol) produced immediate haemodynamic benefits, but its clinical gains remain inferior to CCBs [17]. The two medications produced parallel effects in regulating HR, BNP and aldosterone following 24 weeks of treatment. The short-term use of CCBs managed to decrease aldosterone levels at week 12, but the effect proved non-lasting, which makes extended treatment with CCBs clinically irrelevant [18].

Limitations of this study

The study has some limitations. The 24-week follow-up period may not accurately reveal significant cardiovascular outcomes during extended monitoring periods for both stroke prevention and death rates. Specific data about patients with diabetes and chronic kidney disease, or heart failure, could not be determined because the study did not adequately analyze such patient groups.

CONCLUSION

Treatment with metoprolol and amlodipine significantly improves outcomes in patients with hypertension and atrial fibrillation. Furthermore, calcium channel blockers were better at lowering blood pressure, and β-blockers were far more effective at lowering heart rates. Multi-center studies with larger sample sizes are needed to investigate group-specific treatment solutions for patient care.

DECLARATIONS

Acknowledgement/Funding

None.

Ethical approval

Ethical approval for this study was obtained from the Clinical Laboratory Sciences Department, University of Basrah, Basrah, Iraq (approval no. IE2984059 In -2025-01).

Use of Artificial intelligence/Large language models

We also declare that we did not use Generative artificial intelligence (AI) and AI-assisted technologies in writing the manuscript.

Availability of data and materials

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

Conflict of interest

No conflict of interest is associated with this work.

Contribution of authors

We declare that this work was done by the author(s) named in this article, and all liabilities pertaining to claims relating to the content of this article will be borne by the authors.

REFERENCES

1. *Mills KT, Stefanescu A, He J. The global epidemiology of hypertension. Nat Rev Nephrol 2020; 16(4): 223-237. doi: 10.1038/s41581-019-0244-2.*
2. *Wołowiec Ł, Grześk G, Osiak J, Wijata A, Mędlewska M, Gaborek P, Głowacka M. Beta-blockers in cardiac arrhythmias–Clinical pharmacologist's point of view. Front Pharmacol 2023; 13: 1043714.*
3. *Antoun I, Layton GR, Nizam A, Barker J, Abdelrazik A, Eldesouky M, Ng GA. Hypertension and atrial fibrillation: Bridging the gap between mechanisms, risk, and therapy. Medicina 2025; 61(2): 362.*
4. *Ogawa H, An Y, Ikeda S, Aono Y, Doi K, Ishii M, Iguchi M, Masunaga N, Esato M, Tsuji H, et al. Fushimi AF Registry investigators. Progression from paroxysmal to sustained atrial fibrillation is associated with increased adverse events. Stroke 2018t ;49(10): 2301-2308. doi: 10.1161/STROKEAHA.118.021396. PMID: 30355097.*
5. *Marazzato J, Blasi F, Golino M, Verdecchia P, Angeli F, De Ponti R. Hypertension and arrhythmias: A clinical overview of the pathophysiology-driven management of cardiac arrhythmias in hypertensive patients. J Cardiovasc Dev Dis 2022; 9(4): 110.*

6. Fan B, Zhang J, Zhao JV. Systematic review of Mendelian randomization studies on antihypertensive drugs. BMC Med 2024; 22(1): 547.
7. Lee SJ, Park J, Park JK, Kang KW, Shim J, Choi EK, Kim J, Kim JB, Lee YS, Park HW, et al. Association between atrial fibrillation symptoms and clinical outcomes: a prospective multicenter registry study. The Am J Cardiol 2024; 217: 68-76.
8. Chourdakis E, Koniari I, Velissaris D, Tsigkas G, Kounis NG, Osman N. Beta-blocker treatment in heart failure patients with atrial fibrillation: challenges and perspectives. J Geriatr Cardiol 2021; 18(5): 362-375. doi: 10.11909/j.issn.1671-5411.2021.05.008.
9. McKeever RG, Patel P, Hamilton RJ. Calcium channel blockers. (Updated 22 Feb 2024). In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2025. Available from: https://www.ncbi.nlm.nih.gov/books/NBK482473/.
10. Netala VR, Teertam SK, Li H, Zhang Z. A comprehensive review of cardiovascular disease management: Cardiac biomarkers, imaging modalities, pharmacotherapy, surgical interventions, and herbal remedies. Cells 2024; 13(17): 1471.
11. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA 2013; 310(20): 2191-2194.
12. Alhajj M, Zubair M, Farhana A. Enzyme-Linked Immunosorbent Assay (ELISA). In StatPearls. Treasure Island (FL): StatPearls Publishing. 2023
13. Li T, Ma Y, Zhang Y, Liu Y, Fu T, Zhang R, Kang K, Yang Y, Wang L, Jiang Y, et al. Feasibility of screening primary aldosteronism by aldosterone-to-direct renin concentration ratio derived from chemiluminescent immunoassay measurement: diagnostic accuracy and cutoff value. Int J Hypertens 2019; 2019: 2195796. doi: 10.1155/2019/2195796.
14. Enge K, Tveit A, Enger S, Onarheim S, Pripp AH, Rønningen PS, Ulimoen SR. Diltiazem reduces levels of NT-proBNP and improves symptoms compared with metoprolol in patients with permanent atrial fibrillation. Eur Heart J Cardiovasc Pharmacother 2024; 10(6): 515-525.
15. Patel RB, Greene SJ, Xu H, Alhanti B, Peterson P, Yancy CW, Piccini J, Fonarow GC, Vaduganathan M. Intersection of atrial fibrillation and heart failure with mildly reduced and preserved ejection fraction in >400 000 participants in the get with the guidelines-heart failure registry. Eur J Heart Fail 2023; 25(1): 63-73. doi: 10.1002/ejhf.2729.
16. Shouval R, Goldman A, Flynn JR, El-Moghraby A, Rehman M, Devlin SM, Corona M, Landego I, Lin RJ, Scordo M, et al. Atrial arrhythmias following CAR-chimeric antigen receptor T-cell therapy: Incidence, risk factors and biomarker profile. Brit J Haematol 2024; 205(3): 978-989.
17. Floria M, Oancea AF, Morariu PC, Burlacu A, Iov DE, Chiriac CP, Tanase DM. An overview of the pharmacokinetics and pharmacodynamics of landiolol (an ultra-short-acting β1 selective antagonist) in atrial fibrillation. Pharmaceutics 2024; 16(4): 517.
18. Meyer M, Wetmore JB, Weinhandl ED, Roetker NS. Association of nondihydropyridine calcium channel blockers versus β-adrenergic receptor blockers with risk of heart failure hospitalization. Am J Cardiol 2023; 197: 68-74. doi: 10.1016/j.amjcard.2023.04.013.