International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Anatomical Variations in Coronary Artery Dominance and Their Influence on Hemodynamic Responses and Beta-Blocker Efficacy: A Prospective Observational Study

Dr Abin Augustine[1], Dr Rinku Mariam George[2], Dr Anagha A L[3]

[1]Assistant Professor, Department of Pharmacology, Azeezia Institute of Medical Sciences and Research, Meeyannoor, Kollam, Kerala, India

[2]Assistant Professor, Department of Anatomy, Azeezia Institute of Medical Sciences and Research, Meeyannoor, Kollam, Kerala, India

[3]Assistant Professor, Department of Physiology, Azeezia Institute of Medical Sciences and Research, Meeyannoor, Kollam, Kerala, India.

OPEN ACCESS

Corresponding Author:

Dr Abin Augustine
Assistant Professor,
Department of Pharmacology,
Azeezia Institute of Medical Sciences and Research,
Meeyannoor, Kollam, Kerala, India

Received: 15-12-2025
Accepted: 19-01-2026
Available online: 28-02-2026

ABSTRACT

Background: Coronary artery dominance determines the perfusion territory of the inferior wall and portions of the conduction system, and could modify physiological responses to rate- and pressure-lowering therapy.
Objectives: To describe coronary dominance patterns and evaluate their association with short-term hemodynamic response to beta-blocker therapy.
Methods: This prospective observational study was conducted at Azeezia Institute of Medical Sciences and Research, Kollam, Kerala, over six months (May–October 2025). Adults undergoing coronary angiography and initiated on beta-blocker therapy were followed for eight weeks. Heart rate and blood pressure were recorded at baseline and at follow-up. Changes in hemodynamic parameters were compared across right-dominant, left-dominant, and co-dominant circulation patterns.
Results: Among 100 participants (mean age 54.8±10.6 years; 62% male), right dominance was observed in 72%, left dominance in 18%, and co-dominance in 10%. Baseline heart rate and blood pressure were comparable across dominance groups. After eight weeks, the overall mean change in heart rate was −14.8±6.2 beats/min and systolic blood pressure was −16.9±10.3 mmHg. Reductions were greatest in right-dominant circulation for heart rate (−16.1±5.8 beats/min) and systolic blood pressure (−18.6±10.4 mmHg), with significant between-group differences for heart rate (p=0.02) and systolic pressure (p=0.04).
Conclusion: In this cohort, right-dominant coronary circulation was associated with a larger chronotropic and systolic blood pressure response to beta-blocker therapy over eight weeks. Coronary dominance could be a simple anatomical modifier to consider when individualizing beta-blocker titration in routine practice.

Keywords: coronary dominance; coronary angiography; hemodynamics; beta-blockers; heart rate; blood pressure; observational study.

INTRODUCTION

Coronary artery dominance describes which epicardial artery gives rise to the posterior descending artery and the dominant posterolateral branches that perfuse the inferior interventricular septum and diaphragmatic left ventricular wall [1]. Although classically described as right dominance, left dominance, or balanced/co-dominance, dominance is not a purely anatomical curiosity; it defines the size of perfusion territories and can influence vulnerability during ischemia and reperfusion. Large imaging series using multidetector computed tomographic coronary angiography have reported right dominance in approximately two-thirds to three-quarters of individuals, with left dominance and balanced circulation comprising smaller fractions [2]. Postmortem angiographic work further suggests that the prevalence of left and balanced

dominance decreases with advancing age, indicating that population structure and selection can shape observed dominance patterns in clinical cohorts [4].

Beyond perfusion of the inferior wall, dominance is closely linked to the arterial supply of the sinoatrial and atrioventricular nodes. Angiographic data from South Indian populations demonstrate that the right coronary artery supplies the atrioventricular node in a large proportion of cases, with variations that correlate with dominance [3]. Such anatomical relationships provide a plausible substrate for inter-individual differences in heart rate control, conduction stability, and autonomic responses under pharmacologic modulation. In parallel, observational data have associated left or co-dominant circulation with adverse outcomes in acute coronary syndromes treated with percutaneous coronary intervention, including higher in-hospital mortality and long-term event rates [5–7]. Meta-analytic evidence similarly indicates that left coronary dominance can be linked to worse post-intervention outcomes, supporting the view that dominance is clinically meaningful rather than incidental [8]. Coronary dominance has also been examined in relation to angiographic disease burden, with some cohorts reporting associations between dominance pattern and severity scores [9].

Beta-blockers remain foundational agents for heart rate control and blood pressure reduction, and are frequently prescribed in patients undergoing evaluation for suspected or established coronary artery disease. Systematic review evidence in primary hypertension shows that beta-1 selective blockers lower systolic and diastolic pressures while producing a consistent reduction in heart rate, reflecting combined hemodynamic and neurohumoral effects [10]. Controlled hemodynamic studies with metoprolol demonstrate prompt reductions in heart rate and systolic pressure, highlighting the magnitude of central and peripheral changes that can occur under beta-adrenergic blockade [11]. However, whether coronary dominance modifies the short-term hemodynamic response to beta-blocker therapy in real-world practice is not well characterized, particularly in Indian tertiary-care settings where disease phenotype and treatment patterns can differ.

Therefore, the present prospective observational study was designed to (i) describe the distribution of coronary dominance patterns in adults undergoing coronary angiography and (ii) compare eight-week changes in heart rate and blood pressure after beta-blocker therapy across dominance groups.

MATERIALS AND METHODS

Study design and setting

A prospective observational study was conducted in the Department of Cardiology, Azeezia Institute of Medical Sciences and Research, Kollam, Kerala, India. The study period was six months (May 2025 to October 2025). The study was reported in line with STROBE recommendations for observational research.

Participants and sampling

Consecutive adults undergoing diagnostic coronary angiography for suspected or known coronary artery disease and initiated on oral beta-blocker therapy as part of routine care were screened. A total of 100 eligible participants were enrolled over the study period. Exclusion criteria included baseline heart rate <60 beats/min, second- or third-degree atrioventricular block without pacing, decompensated heart failure, severe bronchospastic disease, systolic blood pressure <100 mmHg, pregnancy, and inability to complete follow-up.

Assessment of coronary dominance

Coronary dominance was determined from coronary angiography by an interventional cardiologist blinded to follow-up hemodynamics. Right dominance was defined by origin of the posterior descending artery from the right coronary artery, left dominance by origin from the left circumflex artery, and co-dominance by contributions from both systems to the inferior wall through posterior descending and posterolateral branches.

Hemodynamic measurements

Resting heart rate and brachial blood pressure were measured at baseline (pre-discharge or at initial outpatient initiation of beta-blocker) and again at 8 weeks. Measurements were obtained in the seated position after at least 5 minutes of rest using a validated automated oscillometric device, with an appropriately sized cuff. Two readings were recorded 1–2 minutes apart, and the average was used for analysis, consistent with standard adult blood pressure measurement recommendations [12].

Beta-blocker therapy and follow-up

Beta-blocker therapy was prescribed by the treating cardiologist, with a preference for beta-1 selective agents when not contraindicated. Doses were titrated during routine follow-up to achieve symptom control and a resting heart rate target individualized to clinical context. Participants were reviewed at approximately 4 and 8 weeks, and adherence was reinforced through structured counseling and medication review.

Outcomes

The primary outcomes were change in heart rate (ΔHR) and change in systolic and diastolic blood pressure (ΔSBP, ΔDBP) from baseline to 8 weeks. Beta-blocker efficacy was operationalized as magnitude of reduction in these parameters over follow-up.

Statistical analysis

Continuous variables are presented as mean±standard deviation and categorical variables as counts and percentages. Baseline characteristics and baseline hemodynamic parameters were compared across dominance groups using one-way analysis of variance for continuous variables and the chi-square test for categorical variables. Between-group differences in 8-week changes in HR and BP were assessed using one-way analysis of variance. A two-sided p-value <0.05 was considered statistically significant. Analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA).

Ethical considerations

Institutional Ethics Committee approval was obtained prior to study initiation. Written informed consent was obtained from all participants. Confidentiality was ensured by anonymized coding of study records and restricted access to data for research purposes only.

RESULTS:

Baseline demographic characteristics are summarized in Table 1. The cohort had a mean age of 54.8±10.6 years, and 62 participants (62.0%) were male. Right-dominant circulation was the most frequent pattern (72.0%), followed by left dominance (18.0%) and co-dominance (10.0%) (Table 2).

Table 1. Baseline demographic and clinical characteristics (N = 100).

Variable	Overall (n=100)	Right dominance (n=72)	Left dominance (n=18)	Co-dominance (n=10)
Age (years), mean ± SD	54.8 ± 10.6	54.2 ± 10.4	56.7 ± 11.1	55.1 ± 10.2
Male sex, n (%)	62 (62.0)	46 (63.9)	10 (55.6)	6 (60.0)

Table 2. Distribution of coronary artery dominance (N = 100).

Coronary dominance pattern	n	%
Right dominance	72	72.0
Left dominance	18	18.0
Co-dominance	10	10.0

Baseline hemodynamic parameters were broadly comparable across dominance patterns (Table 3). Mean resting heart rate was 86.3±9.4 beats/min and mean systolic and diastolic blood pressures were 148.6±14.2 mmHg and 92.4±8.7 mmHg, respectively; no statistically significant between-group differences were observed at baseline (p>0.05 for all).

Table 3. Baseline hemodynamic parameters by coronary dominance (N = 100).

Parameter (baseline)	Overall (n=100) mean ± SD	Right (n=72)	Left (n=18)	Co-dominant (n=10)	p-value*
Heart rate (beats/min)	86.3 ± 9.4	86.6 ± 9.2	85.4 ± 9.8	86.0 ± 9.6	>0.05
Systolic BP (mmHg)	148.6 ± 14.2	149.1 ± 14.0	147.2 ± 15.1	148.0 ± 13.6	>0.05
Diastolic BP (mmHg)	92.4 ± 8.7	92.6 ± 8.6	91.8 ± 9.0	92.1 ± 8.3	>0.05

*p-value across dominance groups (one-way ANOVA).

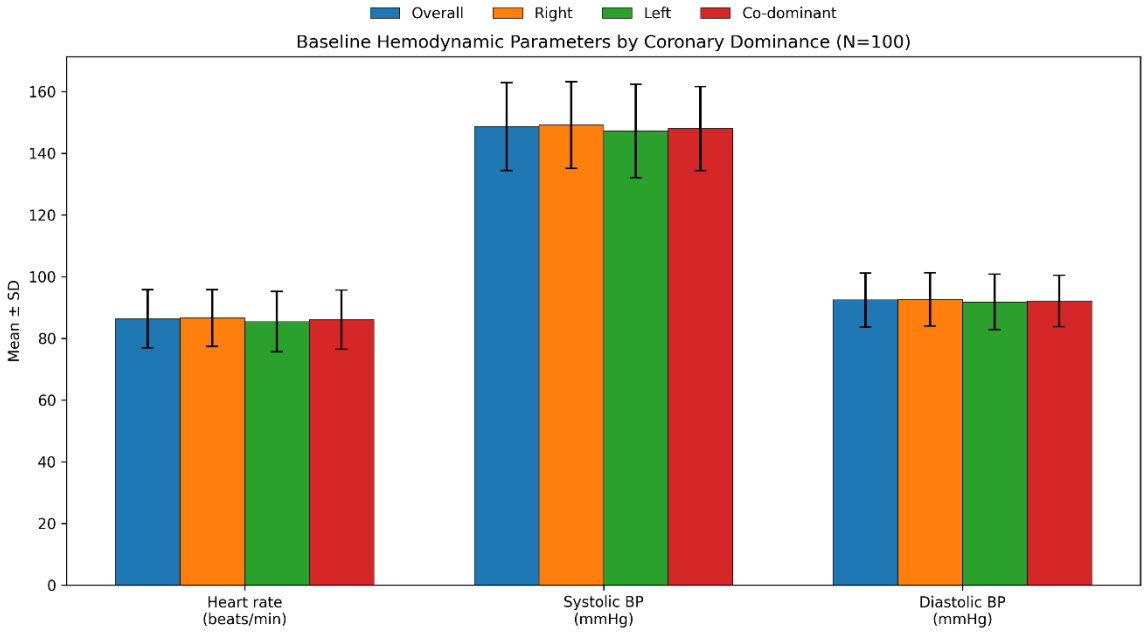

Figure 1: Baseline hemodynamic parameters by coronary dominance

After 8 weeks of beta-blocker therapy, significant reductions in heart rate and blood pressure were observed overall (Table 4). The magnitude of heart-rate reduction differed across dominance groups, with the largest mean ΔHR in right-dominant circulation (−16.1±5.8 beats/min) compared with left dominance (−11.3±6.5 beats/min) and co-dominance (−12.4±5.9 beats/min) (p=0.02). Systolic blood pressure reduction was also greatest in the right-dominant group (−18.6±10.4 mmHg), with significant between-group differences (p=0.04). Diastolic blood pressure showed a numerically greater reduction in right dominance, but the between-group difference did not meet statistical significance (p=0.08).

Table 4. Change in hemodynamic parameters after 8 weeks of beta-blocker therapy by coronary dominance (N = 100).

Outcome (change from baseline)	Overall mean ± SD	Right (n=72)	Left (n=18)	Co-dominant (n=10)	p-value*
Δ Heart rate (beats/min)	−14.8 ± 6.2	−16.1 ± 5.8	−11.3 ± 6.5	−12.4 ± 5.9	0.02
Δ Systolic BP (mmHg)	−16.9 ± 10.3	−18.6 ± 10.4	−12.7 ± 9.8	−14.2 ± 8.9	0.04
Δ Diastolic BP (mmHg)	−7.1 ± 6.4	−7.8 ± 6.2	−5.6 ± 6.6	−6.3 ± 6.1	0.08

*p-value across dominance groups (one-way ANOVA).

DISCUSSION

This prospective observational study described coronary dominance patterns in adults undergoing coronary angiography and explored whether dominance was linked to short-term hemodynamic response after beta-blocker initiation. Right dominance was most frequent (72%), consistent with large computed tomographic angiography series reporting right dominance in about 70% of individuals [2]. The proportion of left dominance (18%) exceeded that seen in many unselected populations, where left dominance often falls near 10% [2]. Such differences are plausible in referral cohorts, and postmortem angiographic work suggests that dominance proportions vary across samples and age structures [4].

Accumulating evidence indicates that dominance carries prognostic information in acute coronary syndromes and revascularization settings. National registry data have linked left and co-dominant circulation with higher in-hospital mortality after PCI for acute coronary syndromes [5]. Long-term follow-up studies in ST-segment elevation myocardial infarction treated with primary angioplasty have also reported worse outcomes among patients with left dominance [6], and two-year observational data after PCI show event differences across dominance patterns [7]. Meta-analytic synthesis supports an overall association between left dominance and adverse post-PCI outcomes [8]. These observations emphasize that a larger territory at risk or less favorable collateralization in left dominance can translate to clinically relevant vulnerability.

In the current cohort, baseline heart rate and blood pressure did not differ across dominance groups, suggesting that resting hemodynamics at presentation were not strongly determined by dominance alone. After eight weeks of beta-blocker therapy, reductions in heart rate and systolic pressure were greatest in right dominance, with statistically significant between-group differences. Overall, the magnitude of BP and heart-rate lowering was directionally consistent with pooled evidence for beta-1 selective blockers in hypertension, which shows parallel reductions in pressure and heart rate [10]. Short-term physiological studies with metoprolol likewise demonstrate measurable decreases in heart rate and systolic pressure after initiation [11], supporting the plausibility of the observed changes over an eight-week window.

The dominance-linked gradient in chronotropic and systolic response should be interpreted cautiously. One mechanistic possibility is that dominance-related perfusion of the inferoposterior myocardium and nodal tissue influences autonomic feedback and sinus node responsiveness under beta-adrenergic blockade. Angiographic data from South Indian populations show that nodal arterial supply frequently arises from the right coronary artery and varies with dominance [3]. Alternatively, dominance might be acting as a surrogate for lesion distribution, ischemic burden, or treatment intensity, because some cohorts report associations between dominance and angiographic disease severity [9]. Clinically, our findings support closer titration and follow-up in left-dominant and co-dominant circulation when target heart rate or systolic pressure reduction is not achieved with beta-blocker therapy alone.

Larger studies with standardized dosing, longer observation, and adjustment for concurrent medications should evaluate whether dominance-related hemodynamic differences persist and whether they translate into patient-centered outcomes.

Limitations

This study has limitations. The sample was modest and drawn from a single center, limiting generalizability. Coronary dominance was defined by angiography alone; microvascular perfusion and collateral flow were not evaluated. Beta-blocker selection and titration followed routine clinical care, introducing dose heterogeneity. Follow-up was limited to eight weeks, preventing assessment of sustained responses. Potential confounders, including concurrent antihypertensive drugs, physical activity, and dietary sodium intake, were not measured**.**

CONCLUSION

This prospective observational study found that right-dominant coronary circulation was the most common pattern among adults undergoing coronary angiography at a tertiary center in Kerala. Baseline heart rate and blood pressure were similar across dominance groups. After eight weeks of beta-blocker therapy, right dominance showed significantly greater reductions in heart rate and systolic blood pressure than left dominance or co-dominance, while diastolic pressure changes were not statistically different. These findings suggest that coronary dominance can act as an anatomical modifier of short-term beta-blocker response. Recognizing dominance during angiographic reporting could help clinicians individualize titration and consider earlier combination therapy when hemodynamic targets are not achieved.

REFERENCES

1. Shahoud JS, Ambalavanan M, Tivakaran VS. Cardiac dominance. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan. PMID: 30725892.
2. Eren S, Bayram E, Fil F, Koplay M, Sirvanci M, Duran C, Sagsoz ME, Diyarbakir S, Okur A, Kantarci M. An investigation of the association between coronary artery dominance and coronary artery variations with coronary arterial disease by multidetector computed tomographic coronary angiography. **J Comput Assist Tomogr.** 2008;32(6):929-933. doi:10.1097/RCT.0b013e3181593d5b. PMID: 19204457.
3. Ramanathan L, Shetty P, Nayak SR, Krishnamurthy A, Chettiar GK, Chockalingam A. Origin of the sinoatrial and atrioventricular nodal arteries in South Indians: an angiographic study**. Arq Bras Cardiol.** 2009;92(5):314-319, 330-335, 342-348. doi:10.1590/S0066-782X2009000500002. PMID: 19629284.
4. Knaapen M, Koch AH, Koch C, Koch KT, Li X, van Rooij PC, Tijssen JGP, Peters RJ, van der Wal AC, Damman P, de Winter RJ. Prevalence of left and balanced coronary arterial dominance decreases with increasing age of patients at autopsy: a postmortem coronary angiograms study. **Cardiovasc Pathol.** 2013;22(1):49-53. doi:10.1016/j.carpath.2012.02.012. PMID: 22463919.
5. Parikh NI, Honeycutt EF, Roe MT, Neely M, Rosenthal EJ, Mittleman MA, Carrozza JP Jr, Ho KKL. Left and codominant coronary artery circulations are associated with higher in-hospital mortality among patients undergoing percutaneous coronary intervention for acute coronary syndromes: report from the National Cardiovascular Database CathPCI Registry. **Circ Cardiovasc Qual Outcomes.** 2012;5(6):775-782. doi:10.1161/CIRCOUTCOMES.111.964593. PMID: 23110791.
6. Abu-Assi E, Castiñeira-Busto M, González-Salvado V, Raposeiras-Roubin S, Abumuaileq RRY, Peña-Gil C, Rigueiro-Veloso P, Ocaranza R, García-Acuña JM, González-Juanatey JR. Coronary artery dominance and long-term prognosis in patients with ST-segment elevation myocardial infarction treated with primary angioplasty. **Rev Esp Cardiol (Engl Ed).** 2016;69(1):19-27. doi:10.1016/j.rec.2015.04.010. PMID: 26228847.

7. He C, Ma YL, Wang CS, Song Y, Tang XF, Zhao XY, Gao RL, Yang YJ, Xu B, Yuan JQ. Effect of coronary dominance on 2-year outcomes after percutaneous coronary intervention in patients with acute coronary syndrome. **Catheter Cardiovasc Interv.** 2017;89(Suppl 1):549-554. doi:10.1002/ccd.26978. PMID: 28318135.
8. Khan MS, Usman MS, Akhtar T, Raza S, Deo S, Kalra A, Nasim MH, Yadav N, Bhatt DL. Meta-analysis evaluating the effect of left coronary dominance on outcomes after percutaneous coronary intervention. **Am J Cardiol.** 2018;122(12):2026-2034. doi:10.1016/j.amjcard.2018.09.002. PMID: 30477724.
9. Yan B, Yang J, Fan Y, Zhao B, Ma Q, Yang L, Ma X. Association of coronary dominance with the severity of coronary artery disease: a cross-sectional study in Shaanxi Province, China. **BMJ Open.** 2018;8(11):e021292. doi:10.1136/bmjopen-2017-021292. PMID: 30413496.
10. Wong GWK, Boyda HN, Wright JM. Blood pressure lowering efficacy of beta-1 selective beta blockers for primary hypertension. **Cochrane Database Syst Rev.** 2016;3:CD007451. doi:10.1002/14651858.CD007451.pub2. PMID: 26961574.
11. Held PH, Corbeij HM, Dunselman P, Hjalmarson A, Murray D, Swedberg K. Hemodynamic effects of metoprolol in acute myocardial infarction: a randomized, placebo-controlled multicenter study. **Am J Cardiol.** 1985;56(14):47G-54G. doi:10.1016/0002-9149(85)90697-6. PMID: 3904394.
12. Whelton PK, Carey RM, Aronow WS, Casey DE Jr, Collins KJ, Dennison Himmelfarb C, DePalma SM, Gidding S, Jamerson KA, Jones DW, MacLaughlin EJ, Muntner P, Ovbiagele B, Smith SC Jr, Spencer CC, Stafford RS, Taler SJ, Thomas RJ, Williams KA Sr, Williamson JD, Wright JT Jr. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults. **Hypertension.** 2018;71(6):e13-e115. doi:10.1161/HYP.0000000000000065. PMID: 29133356.
13. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. **Ann Intern Med.** 2007;147(8):573-577. doi:10.7326/0003-4819-147-8-200710160-00010. PMID: 17938396.
14. Vandenbroucke JP, von Elm E, Altman DG, Gøtzsche PC, Mulrow CD, Pocock SJ, Poole C, Schlesselman JJ, Egger M; STROBE Initiative. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. **Ann Intern Med.** 2007;147(8):W163-W194. doi:10.7326/0003-4819-147-8-200710160-00010-w1. PMID: 17938389.