



Ventral Cardiac Denervation to Reduce Postoperative Atrial Fibrillation after Coronary Artery Bypass Grafting: A Quasi-Experimental Study

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ARTICLE INFO

Keywords: Atrial fibrillation, arrhythmia, CABG surgery, cardiac denervation

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Declaration

Authors' Contribution: All authors equally contributed to the study and approved the final manuscript.

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History

Received: 12-02-2025 Revised: 05-05-2025
Accepted: 13-05-2025 Published: 30-05-2025

ABSTRACT

Objective: To assess the effectiveness of ventral cardiac denervation (VCD) in reducing the incidence of postoperative atrial fibrillation (POAF) in patients undergoing elective coronary artery bypass grafting (CABG). **Study Design:** Quasi-experimental study. **Place and Duration of Study:** Department of Cardiac Surgery, Rawalpindi Institute of Cardiology, Rawalpindi, for six months (July to December 2024). **Methods:** Ninety-eight patients undergoing elective CABG were divided into two equal groups. Group A underwent conventional CABG, while Group B underwent CABG with ventral cardiac denervation achieved by excision of epicardial fat pads surrounding the superior vena cava, ascending aorta, and aortopulmonary groove. Continuous telemetry monitoring was used for the detection of POAF. **Results:** In the CABG-only group, 38.8% patients had postoperative atrial fibrillation as compared with 26.5% patients in the VCD group ($p = 0.18$). Mean hospital stay was shorter in the VCD group (6.9 ± 1.4 days vs. 7.4 ± 1.6 days; $p = 0.09$). **Conclusion:** Ventral cardiac denervation showed a trend toward reduction in postoperative atrial fibrillation and hospital stay; however, these differences did not reach statistical significance.

INTRODUCTION

Atrial fibrillation is a common postoperative complication following coronary artery bypass grafting (CABG), with a reported incidence ranging from 5% to 40% [1–3]. It is associated with increased morbidity, prolonged hospital stay, and thromboembolic complications. Regional data have also shown a considerable burden of postoperative atrial fibrillation in South Asia, which may be related to the higher prevalence of cardiovascular risk factors such as diabetes mellitus, hypertension, and metabolic syndrome [4]. Although postoperative atrial fibrillation has traditionally been regarded as a self-limiting and relatively benign event, recurrence occurs in a substantial proportion of patients, with up to 76% experiencing further episodes within the first postoperative year [5, 6]. The pathogenesis of postoperative atrial fibrillation is multifactorial and includes autonomic imbalance, inflammation, oxidative stress, and atrial substrate changes resulting from ischemia, surgical trauma, and associated comorbid conditions [6]. Various preventive strategies have been explored, including perioperative beta-blockers, amiodarone prophylaxis, statins, magnesium supplementation, digoxin, and biatrial pacing

techniques [7]. Although these interventions have shown varying degrees of effectiveness, their use may be limited by contraindications, adverse effects, cost, or inconsistent results. Cardiac denervation was first introduced in 1936 by Arnulff [8]. It became more widely used in the 1970s for the prevention of coronary artery spasm and has since been investigated for its potential role in reducing postoperative arrhythmias [9,10]. Melo et al. reported that ventral cardiac denervation is a rapid and safe procedure that significantly reduces both the incidence and severity of atrial fibrillation after CABG [11]. However, the procedure is not without limitations, as incomplete or variable denervation may occur because of anatomical variation, and its long-term effects on cardiac autonomic regulation remain uncertain.

Despite the substantial clinical burden of postoperative atrial fibrillation, evidence regarding autonomic modulation strategies such as ventral cardiac denervation remains limited in South Asian populations. In addition, patients from South Asia often present at a younger age and carry a high burden of metabolic and inflammatory risk factors, which may influence autonomic tone and susceptibility to postoperative atrial fibrillation differently

from Western populations. Most available data on ventral cardiac denervation have been derived from Western settings, and region-specific studies examining its efficacy, safety, and clinical relevance in South Asian patients are scarce. Therefore, this study was conducted to evaluate the impact of ventral cardiac denervation on the incidence of postoperative atrial fibrillation in patients undergoing elective coronary artery bypass grafting

MATERIAL AND METHODS

This quasi-experimental study was conducted at the Department of Cardiac Surgery, Rawalpindi Institute of Cardiology, Rawalpindi, over a one-year period from July 2024 to December 2025. A total of 98 patients undergoing elective coronary artery bypass grafting were included in the study and were allocated into two equal groups of 49 patients each using an alternate allocation method to maintain balanced group sizes. Group A underwent conventional coronary artery bypass grafting alone, whereas Group B underwent coronary artery bypass grafting with ventral cardiac denervation. Written informed consent was obtained from all participants before enrolment, and the study protocol was approved by the institutional ethical review committee.

Patients aged 18 years or older undergoing elective, isolated primary coronary artery bypass grafting, who were in sinus rhythm preoperatively and provided consent for participation, were eligible for inclusion. Patients with chronic atrial fibrillation or other significant arrhythmias, previous history of atrial fibrillation, emergency, urgent, or redo cardiac surgery, concomitant cardiac procedures such as valve or congenital surgery, significant structural heart disease other than coronary artery disease, or severe systemic illness likely to affect postoperative outcomes were excluded. All procedures were performed using standardized operative techniques by multiple surgeons at the same center. Anaesthetic management, including premedication, induction, maintenance, and reversal, was kept uniform in both groups. Myocardial protection was achieved with antegrade cold blood Del Nido cardioplegia.

In the ventral cardiac denervation group, the procedure was performed immediately before initiation of cardiopulmonary bypass. Ventral cardiac denervation was achieved by excision of the adventitia and periadventitial fat using forceps and electrocautery, with circumferential dissection around the superior vena cava, proximal ascending aorta, and pulmonary artery. This dissection was intended to interrupt autonomic nerve fibers supplying the heart while adding minimal operative risk. The technique increased operative time by approximately five minutes. Standard cardiopulmonary bypass was then established through aortic and two-stage venous cannulation, with systemic hypothermia maintained at 32–33°C. Rewarming was started during the final distal anastomosis, and cardiopulmonary bypass was gradually discontinued thereafter.

Postoperatively, all patients were monitored with high-resolution continuous telemetry from day 0 to postoperative day 4. Patients receiving preoperative beta-blockers, calcium channel blockers, or angiotensin-converting enzyme inhibitors were restarted on these

medications 24 hours after surgery. No prophylactic antiarrhythmic treatment was given. Electrolytes and blood gases were closely monitored, with institutional targets of serum potassium 4.5–5.0 mEq/L, magnesium up to 2.0 mEq/L, partial pressure of oxygen above 80 mmHg, and partial pressure of carbon dioxide below 40 mmHg. Postoperative atrial fibrillation was defined as new-onset atrial fibrillation lasting at least 30 seconds and confirmed by electrocardiography or telemetry. Intraoperative or postoperative atrial fibrillation was managed by correction of electrolyte or respiratory abnormalities followed by intravenous amiodarone, while hemodynamically unstable patients underwent immediate synchronized direct-current cardioversion.

Sample size was calculated using OpenEpi software for comparison of two independent proportions, assuming an expected postoperative atrial fibrillation incidence of 34% in the control group and 29% in the ventral cardiac denervation group, with a 95% confidence level, 90% power, and a 1:1 allocation ratio. The required sample size was 49 patients per group, giving a total of 98 patients. Data were analyzed using Statistical Package for the Social Sciences version 25.0. Continuous variables were expressed as mean \pm standard deviation, whereas categorical variables were presented as frequencies and percentages. Independent samples t-test was used for continuous variables, including age, left ventricular ejection fraction, cardiopulmonary bypass time, aortic cross-clamp time, number of grafts, and hospital stay. Chi-square test was applied for categorical variables, including gender, diabetes mellitus, hypertension, extent of coronary artery disease, and postoperative atrial fibrillation. A p-value of 0.05 or less was considered statistically significant.

RESULTS

A total of 98 patients were included in the study, with 49 patients allocated to the conventional coronary artery bypass grafting group and 49 patients to the coronary artery bypass grafting plus ventral cardiac denervation group. Baseline demographic, clinical, and operative characteristics were comparable between the two groups, and no statistically significant differences were observed. The mean age was 53.1 \pm 5.9 years in the coronary artery bypass grafting-only group and 52.4 \pm 6.2 years in the ventral cardiac denervation group ($p = 0.53$). Male patients constituted 73.5% and 71.4% of the two groups, respectively. Similarly, diabetes mellitus, hypertension, extent of coronary artery disease, left ventricular ejection fraction, cardiopulmonary bypass time, aortic cross-clamp time, and number of grafts per patient were not significantly different between the groups, indicating satisfactory baseline comparability.

Postoperative atrial fibrillation occurred in 19 patients (38.8%) in the conventional coronary artery bypass grafting group compared with 13 patients (26.5%) in the ventral cardiac denervation group. Although the frequency was lower in the ventral cardiac denervation arm, the difference did not reach statistical significance ($p = 0.18$). The mean duration of hospital stay was also shorter in the ventral cardiac denervation group, measuring 6.9 \pm 1.4 days compared with 7.4 \pm 1.6 days in the conventional

group; however, this difference was likewise not statistically significant ($p = 0.09$). No major procedure-related complications were observed in either group during the study period.

Table 1
Baseline Demographic, Clinical, and Operative Characteristics of the Study Groups

Variable	CABG only (n=49)	CABG + VCD (n=49)	p-value
Age (years), mean \pm SD	53.1 \pm 5.9	52.4 \pm 6.2	0.53
Male gender, n (%)	36 (73.5)	35 (71.4)	0.81
Diabetes mellitus, n (%)	23 (46.9)	21 (42.9)	0.69
Hypertension, n (%)	30 (61.2)	28 (57.1)	0.68
Left main disease, n (%)	10 (20.4)	9 (18.4)	0.80
Single-vessel disease, n (%)	6 (12.2)	7 (14.3)	0.76
Double-vessel disease, n (%)	15 (30.6)	14 (28.6)	0.83
Triple-vessel disease, n (%)	28 (57.1)	28 (57.1)	1.00
Left ventricular ejection fraction (%), mean \pm SD	52.6 \pm 6.8	53.4 \pm 7.1	0.56
Cardiopulmonary bypass time (min), mean \pm SD	96.2 \pm 18.5	99.1 \pm 17.9	0.43
Aortic cross-clamp time (min), mean \pm SD	68.3 \pm 13.4	70.1 \pm 12.9	0.49
Grafts per patient, mean \pm SD	3.1 \pm 0.6	3.2 \pm 0.5	0.41

Table 2
Postoperative Outcomes in the Study Groups

Outcome	CABG only (n=49)	CABG + VCD (n=49)	p-value
Postoperative atrial fibrillation, n (%)	19 (38.8)	13 (26.5)	0.18
Hospital stay (days), mean \pm SD	7.4 \pm 1.6	6.9 \pm 1.4	0.09

DISCUSSION

Postoperative atrial fibrillation is a frequent complication after coronary artery bypass grafting, with reported incidence ranging from 5% to 40% [1,2]. In the present study, ventral cardiac denervation was associated with a lower frequency of postoperative atrial fibrillation and a slightly shorter hospital stay compared with conventional coronary artery bypass grafting alone, although these differences did not reach statistical significance. These findings are generally in line with previous reports, particularly the work of Melo et al., who showed that ventral cardiac denervation may reduce both the incidence and severity of postoperative atrial fibrillation after coronary artery bypass grafting [11,12].

The development of postoperative atrial fibrillation is complex and involves several interacting mechanisms, among which autonomic imbalance appears to have an important role. Cardiac autonomic fibers pass mainly through the periadventitial fat and connective tissue surrounding the superior vena cava, aortic root, and pulmonary artery, with additional fibers reaching the atria through thoracic sympathetic branches [12–14]. Sympathetic stimulation increases heart rate and myocardial excitability, whereas parasympathetic stimulation slows conduction and may facilitate re-entry circuits [15,16]. Marked fluctuation in autonomic tone during the perioperative period can therefore trigger ectopic activity and promote atrial fibrillation [17,18]. In addition, surgical trauma, cardiopulmonary bypass, and postoperative inflammatory response may further aggravate this autonomic disturbance [13,19].

Ventral cardiac denervation is intended to interrupt these autonomic inputs and thereby reduce the triggers responsible for postoperative atrial fibrillation. In the present study, postoperative atrial fibrillation occurred in 38.8% of patients in the coronary artery bypass grafting-only group compared with 26.5% in the ventral cardiac denervation group. Although the p-value was not statistically significant, this represents an absolute risk reduction of 12.3%, which may still be clinically relevant. The shorter mean hospital stay in the ventral cardiac denervation group also supports a possible beneficial effect, even though statistical significance was not achieved.

Several reasons may explain the lack of statistical significance in the present study. First, anatomical variation in cardiac autonomic innervation may lead to variable degrees of effective denervation between patients [20,21]. Without direct neural mapping or histological confirmation of the excised tissue, the exact extent of denervation cannot be determined. Second, the use of continuous telemetry in this study may have increased detection of short or asymptomatic atrial fibrillation episodes, thereby raising the observed event rate. Third, the modest sample size may have limited the statistical power to detect a significant difference, despite a visible reduction in event frequency.

Other perioperative factors that may influence postoperative atrial fibrillation, including electrolyte balance, cardiopulmonary bypass duration, hypertension, pharmacological treatment, and baseline comorbidities, were broadly comparable between the two groups. This supports the view that the difference observed may be related to the denervation procedure itself rather than to major baseline imbalance. Importantly, ventral cardiac denervation was found to be safe in this series, added minimal operative time, and was not associated with any major procedure-related complication. These observations are consistent with the view that autonomic modulation may represent a practical adjunctive strategy in selected patients undergoing coronary artery bypass grafting [22].

This study has certain limitations. It was conducted at a single center and used a quasi-experimental design, which may introduce selection bias and limit generalizability. The sample size was relatively small, and longer follow-up was not available to assess recurrent atrial fibrillation beyond the early postoperative period. Despite these limitations, the observed trend toward lower postoperative atrial fibrillation with ventral cardiac denervation is clinically noteworthy and supports the need for larger multicenter randomized studies using standardized denervation techniques and uniform rhythm monitoring protocols.

CONCLUSION

Ventral cardiac denervation demonstrated a 12.3% absolute risk reduction in postoperative atrial fibrillation following CABG; however, statistical significance was not achieved. Larger multicenter trials are warranted to further evaluate its clinical role.

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