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Research Article

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Postoperative Atrial Fibrillation Following Coronary Artery Bypass Surgery Comparison: Between On-Pump *vs.* Off-Pump Technique

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Abstract

Background: Postoperative Atrial Fibrillation (POAF) is a common complication after Coronary Artery Bypass Grafting (CABG) and may prolong intensive care and hospital recovery. On-pump CABG uses cardiopulmonary bypass and cardioplegic arrest, whereas off-pump CABG is performed on the beating heart without cardiopulmonary bypass. These differences may influence inflammation, electrolyte balance and postoperative rhythm stability.

Aim: To compare the occurrence and postoperative outcomes of atrial fibrillation following on-pump CABG and off-pump CABG and to evaluate associated demographic, inflammatory, cardiac, operative, electrolyte and treatment-related factors.

Materials and methods: A comparative study was conducted in the cardiothoracic surgery ICU of Sree Balaji Medical College and Hospital. Thirty adult patients undergoing CABG were included, with 15 patients in the on-pump CABG (ONCABG) group and 15 in the off-pump CABG (OPCABG) group. Convenience sampling was used. Data included demographic characteristics, comorbidities, ECG/rhythm findings, CRP, WBC, IL-6, ejection fraction, operative duration, POAF occurrence and timing, potassium, magnesium, amiodarone use and ICU stay. Data were analyzed using SPSS; categorical variables were expressed as frequency and percentage and comparisons were performed using the statistical tests reported in the thesis, with $p<0.05$ considered significant.

Results: POAF occurred in 11 (73.3%) ONCABG patients compared with 5 (33.3%) OPCABG patients; the study table reports p=0.028. Diabetes was more frequent in ONCABG (12, 80%) than OPCABG (6, 40%; p=0.026). CRP values of 40 mg/dl-100 mg/dl were observed in 11 (73.3%) ONCABG patients compared with 1 (6.6%) OPCABG patient (p=0.001). Higher IL-6 values of 31 pg/ml-75 pg/ml were reported in 11 ONCABG patients (91.75%) compared with 1 OPCABG patient (6.7%; $p<0.001$). Lower potassium and magnesium categories were more frequent in ONCABG (66.7% and 73.3%, respectively), with p=0.011 and p=0.004. Amiodarone use was 73.3% in ONCABG *vs.* 20% in OPCABG (p=0.004). ICU stay of 7-10 days occurred in 73.3% of ONCABG patients compared with 13.3% of OPCABG patients (p=0.001).

Conclusion: In this 30-patient comparative study, ONCABG was associated with a higher occurrence of POAF, greater inflammatory-marker abnormalities, more frequent electrolyte abnormalities, greater amiodarone use and longer ICU stay than OPCABG. The findings support careful postoperative rhythm surveillance and correction of electrolyte disturbances. Larger studies are required to confirm these associations.

Keywords: Postoperative atrial fibrillation; Coronary artery disease; On-pump CABG; Off-pump CABG; Cardiopulmonary bypass; CRP; Interleukin-6; ICU stay

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Introduction

Coronary artery disease is a major cardiovascular condition caused by narrowing or obstruction of the coronary arteries. Coronary artery bypass grafting is an established revascularization procedure in which grafts are used to provide an alternative route around obstructed coronary arteries. CABG may be performed using cardiopulmonary bypass (on-pump CABG) or on the beating heart without cardiopulmonary bypass (off-pump CABG).

Postoperative atrial fibrillation is one of the most frequent arrhythmias after CABG. It is clinically important because it can be associated with hemodynamic instability, thromboembolic complications, prolonged ICU and hospital stay and additional treatment. The pathophysiology of POAF is multifactorial and includes inflammation, oxidative stress, myocardial ischemia-reperfusion, autonomic activation and electrolyte disturbances.

The thesis reviewed evidence suggesting that inflammatory biomarkers such as C-reactive protein and interleukin-6 may be associated with POAF. Cardiopulmonary bypass may increase systemic inflammatory activation, while postoperative potassium and magnesium disturbances may increase myocardial electrical instability. The present study therefore compared POAF and selected postoperative outcomes between ONCABG and OPCABG.

Methodology

Study design and setting

This was a comparative study conducted in the cardiothoracic surgery intensive care unit of Sree Balaji Medical College and Hospital. The study period was six months. Study population and sampling: Adult patients undergoing elective on-pump or off-pump CABG and admitted to the postoperative ICU were included. Convenience sampling was used. The total sample consisted of 30 patients, with 15 patients in each group.

Inclusion criteria

Confirmed coronary artery disease, age ≥30 years and elective CABG by either on-pump or off-pump technique.

Exclusion criteria

It includes emergency CABG, use of antiarrhythmic drugs for reasons other than atrial fibrillation, severe hepatic dysfunction and previous atrial fibrillation.

Data collection

Patient history, ECG, vital signs, echocardiography, intraoperative rhythm, postoperative arterial blood gas, ventilatory settings, atrial fibrillation episode details, CPB details, ICU length of stay, CBC, CRP and IL-6 were assessed. Operative duration, potassium, magnesium and amiodarone use were also evaluated.

Statistical analysis

Data was entered in Microsoft Excel and analyzed using SPSS. Continuous variables were expressed as mean ± standard deviation and categorical variables as frequency and percentage. A p-value <0.05 was considered statistically significant.

Results

Thirty patients were included, with 15 in the ONCABG group and 15 in the OPCABG group. The study evaluated demographic characteristics, comorbidities, inflammatory markers, ejection fraction, operative duration, POAF, postoperative day of POAF, electrolytes, amiodarone use and ICU stay **(Table 1)**.

Table 1: Tabular representation of age category in both groups.

Age (years)	ONCABG n=15	OPCABG n=15	Total percentage	P value
30-50	10(66.7%)	0	33.3%	<0.001
51-75	5(33.3%)	15(100%)	66.7%	

Interpretation

The highest number of patients belonged to age category 51 to 75 (n=20, 67.7%) in both groups and the smallest age category is 30 to 50 with (n=10, 33.3%). The difference the two groups is statically significant P value (<0.001) **(Figure 1 and Table 2)**.

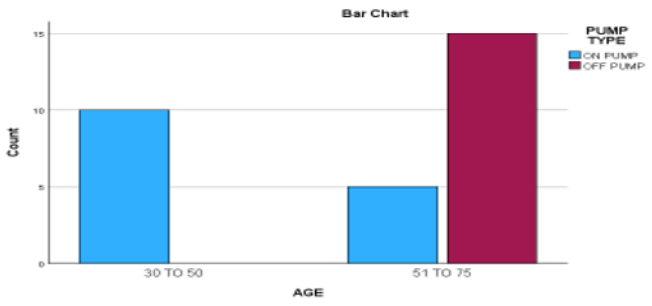


Figure 1: Age category.

Table 2: Tabular representation for gender distribution.

Gender	Frequency	Total percentage	P value
Male	19	63.3%	0.275
Female	11	36.7%	

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Interpretation

Among 30 patient's male patients constituted majority in the study with 19 (63.3%) while female accounted with 11(36.6%). The gender distribution is statistically non-significant P value (0.275) **(Figure 2 and Table 3)**.

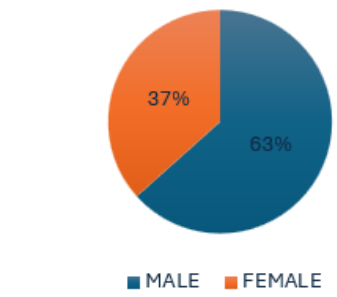


Figure 2: Gender distribution.

Table 3: Tabular representation of HTN in both groups.

HTN	ONCABG n=15	OPCABG n=15	Total percentage	P value
Yes	12(80%)	7(53.3%)	36.70%	
No	3(20%)	8(46.7%)	63.30%	0.054

Interpretation

In on-pump patients has HTN in 12(20%) and not in 3(80%) and in off-pump shows 7(53.3%) patients have HTN remaining 8(46.7%) does not have HTN **(Figure 3 and Table 4)**.

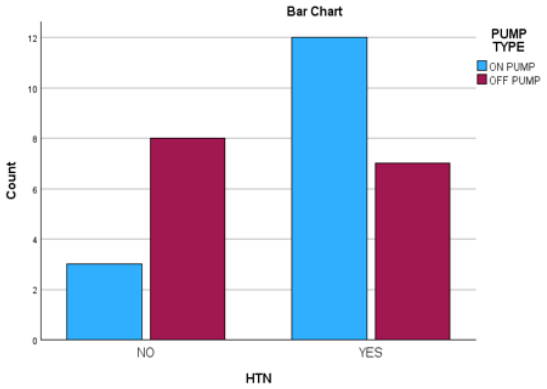


Figure 3: Hypertension.

Table 4: Tabular representation for dm in both groups.

HTN	ONCABG n=15	OPCABG n=15	Total percentage	P value
YES	12(80%)	6(40%)	60%	
NO	3(20%)	9(60%)	40%	0.026

Interpretation

In total 30 patients ONCABG has higher onset in DM. In both groups patients who are present with DM 12(80%) and 6(40%). Patients who are not having in both groups are 3(20%) and 9(60%). This is statically significant p value (0.026) **(Figure 4 and Table 5)**.

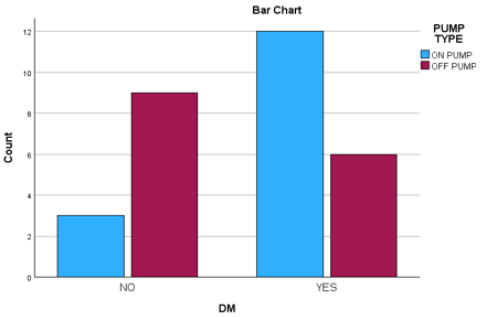


Figure 4: Diabetes mellitus.

Table 5: Tabular representation for CRP levels.

CRP level (mg/dl)	ONCABG n=15	OPCABG n=15	Total percentage	P value
<10	4(26.7%)	10(66.7%)	46.7%	
10-40	0	4(26.7%)	13.3%	0.001
41-100	11(73.3%)	1(6.6%)	40%	

Interpretation

In this tabular column ONCABG has higher value of CRP 11(73.3%) compared to OPCABG 1(6.7%). The increase in the CRP level can trigger postoperative atrial fibrillation. This is statically significant p value (0.001) **(Figure 5 and Table 6)**.

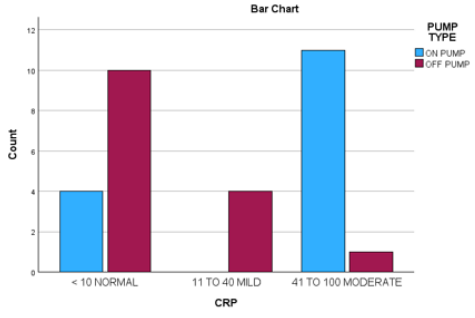


Figure 5: CRP level in the blood.

Table 6: Tabular representation of WBC in both groups.

WBC 10^9/L	ONCABG n=15	OPCABG n=15	Total percentage	P value
7.1-10.9	8(53.3%)	12(80%)	66.70%	
11.1-13.5	7(43.7%)	3(20%)	33.30%	0.097

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Interpretation

The ONCABG patients have increase in WBC level 7 (43.7%) than OPCABG 3(20%) patients. This increase in WBC can cause inflammation to the patients **(Figure 6 and Table 7)**.

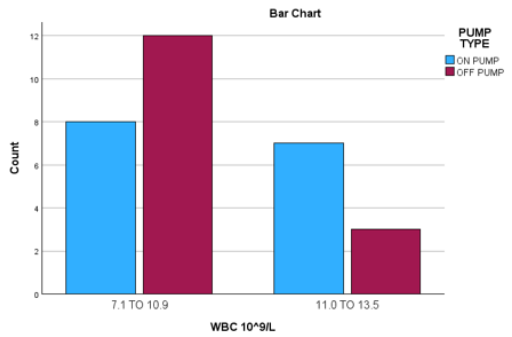


Figure 6: WBC level.

Table 7: Tabular representation of ejection fraction.

EF%	ONCABG n= 15	OPCABG n = 15	Total percentage	P value
50-75	3(20%)	8(53.3%)	36.7%	0.04
40-49	8(53.3%)	5(33.3%)	43.3%	
30-39	4(26.7%)	2(13.3%)	13.3%	

Interpretation

In this tabular column ONCABG patients has lower EF levels 8(53.3%), 4(26.7%) compared to OFCABG 5(33.3%) and 2(13.3%) among the 30 patients **(Figure 7 and Table 8)**.

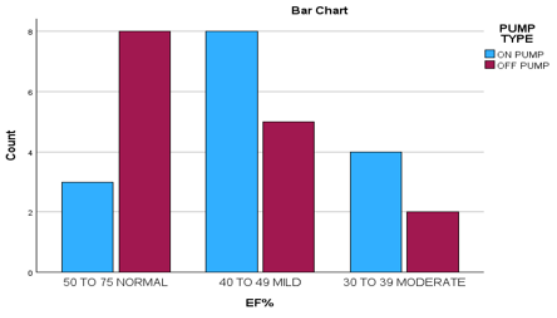


Figure 7: Ejection fraction.

Table 8: Tabular representation of total time in surgery.

Total time (mins)	ONCABG n=15	OPCABG n=15	Total percentage	P value
130-250	5(25%)	15(100%)	66.7%	<0.001
251-330	10(75%)	0	33.3%	

Interpretation

This tabular column displays that the total time for surgery is higher in ONCABG 10(75%) than OPCABG which is zero percent. The increase in surgery time also causes higher chances of POAF in CABG patients **(Figure 8 and Table 9)**.

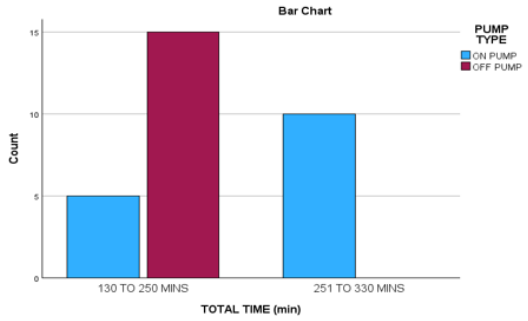


Figure 8: Total time in surgery.

Table 9: Tabular representation of POAF occurrence

POAF occurrence	ONCABG n=15	OPCABG n=15	Total percentage	P value
Yes	11(73.3%)	5(33.3%)	47.7%	0.028
No	4(26.7%)	10(66.7%)	53.3%	

Interpretation

In these ONCABG patients has more POAF occurrence 11(73.3%) compared to OPCABG 5(33.3%). Due to many triggering factors **(Figure 9 and Table 10)**.

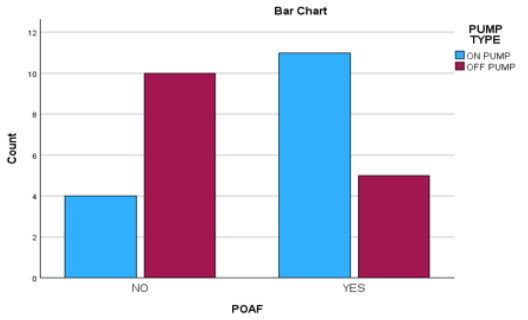


Figure 9: POAF occurrence.

Table 10: Tabular representation for occurrence of POAF during pod in both groups

Post-Op day	ONCABG n=15	OPCABG n=15	Total percentage	P value
0(No POAF)	4(26.7%)	12(80%)	53.3%	0.019
Day 1-2	6(40%)	0	20%	
Day 3-4	5(33.3%)	3(20%)	26.7%	

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Interpretation

This tabular column shows that the occurrence of POAF in postoperative day is higher in ONCABG in 11 patients and 3 in OPCABG, remaining 16 patients does not have POAF occurrence in POD that represents as 0 in below chart **(Figure 10 and Table 11)**.

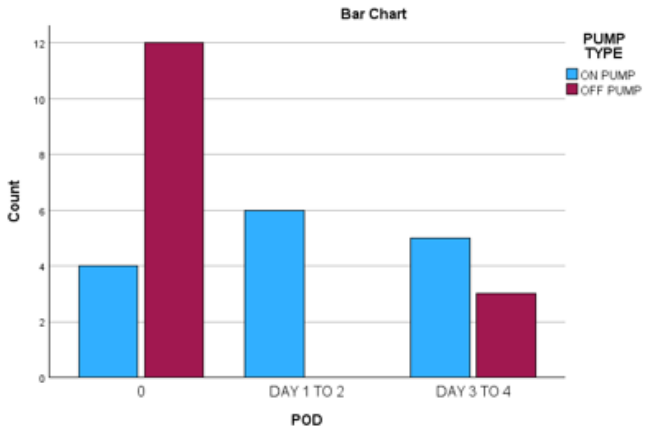


Figure 10: Postostoperative day.

Table 11: Tabular representation of interleukin -6 in both groups.

IL -6 (Pg/ml)	ONCABG n=15	OPCABG n=15	Total percentage	P value
5-30	4(26.7%)	14(93.3%)	60%	<0.001
31-75	11(73.3%)	1(6.7%)	40%	

Interpretation

This tabular column shows that the ONCABG has increased level of IL -6 11(91.75%) than OPCABG 1(6.7%). The increase in interleukin 6 can cause inflammation risk in post-op patients **(Figure 11 and Table 12)**.

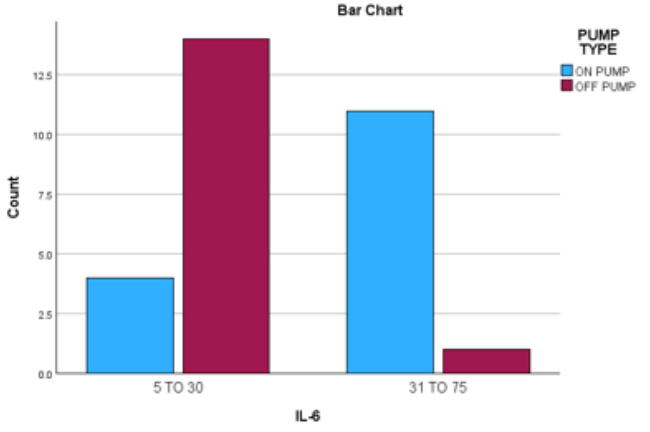


Figure 11: Interleukin -6.

Table 12: Tabular representation of potassium level in both groups.

Potassium (mEq/L)	ONCABG n=15	OPCABG n=15	Total percentage	P value
1.5-2.9	10(66.7%)	3(20%)	43.3%	
3.0-4.2	5(33.3%)	12(80%)	56.7%	0.011

Interpretation

This tabular column shows that the ONCABG has lower potassium levels 10(66.7%) compared to OPCABG 3(20%). Loewer the potassium levels can cause atrial fibrillation in postoperative period **(Figure 12 and Table 13)**.

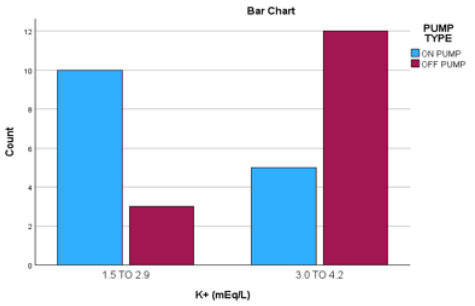


Figure 12: Potassium level.

Table 13: Tabular representation of magnesium level in both groups

Magnesium (mg/dl)	ONCABG n=15	OPCABG n=15	Total percentage	P value
0.5-1.5	11(73.3%)	3(20%)	46.7%	
1.6-2.2	4(26.7%)	12(80%)	53.3%	0.004

Interpretation

In this OPCABG has higher levels of magnesium 12(80%) compared to ONCABG 4(26.7%). Low magnesium levels can cause POAF. It can cause electrolyte disruption **(Figure 13 and Table 14)**.

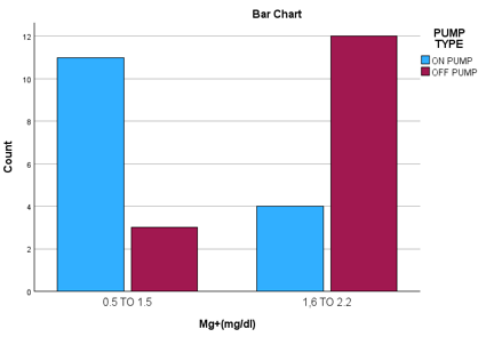


Figure 13: Magnesium level.

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Table 14: Tabular representation of amiodarone given in both groups.

AMIODARONE	ONCABG n=15	OPCABG n=15	Total percentage	P value
Yes	11(73.3%)	3(20%)	53.3%	0.004
No	4(26.7%)	12(80%)	46.7%	

Interpretation

In this ONCABG 11[73.3%] usage of amiodarone compared to OPCABG 3[20%]. The usage of this drug can stop from patients undergoing another AF **(Figure 14 and Table 15)**.

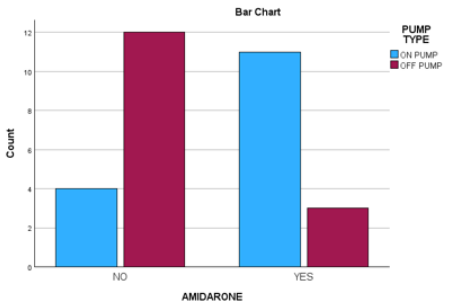


Figure 14: Amiodarone usage.

Table 15: Tabular representation of ICU stay in both groups.

ICU stay	ONCABG n=15	OPCABG n=15	Total percentage	P value
4-6 days	4(26.7%)	13(86.7%)	56.7%	0.001
7-10 days	11(73.3%)	2(13.3%)	43.3%	

Interpretation

This tabular column shows that the ONCABG 11(73.3%) has higher rate of ICU stay compared to OPCABG 2(13.3%). POAF occurrence has increased the stay of patient in ICU. The difference is statistically significant P value (0.001) **(Figure 15)**.

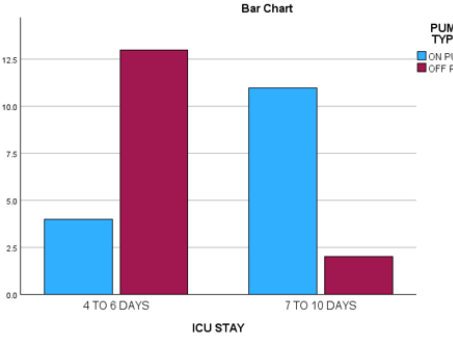


Figure 15: ICU stay in the hospital.

A total of 30 patients undergoing CABG were included, with 15 patients in each group. POAF occurred in 11 (73.3%) ONCABG patients compared with 5 (33.3%) OPCABG patients (p=0.028). Diabetes mellitus was more frequent in ONCABG (80% *vs.* 40%; p=0.026). Inflammatory markers were higher in the ONCABG group, with CRP values of 40 mg/dl-100 mg/dl observed in 73.3% *vs.* 6.7% of patients (p=0.001), while higher IL-6 values of 31 pg/ml-75 pg/ml were observed in 91.75% *vs.* 6.7% (p<0.001). WBC values were also higher in ONCABG, although the difference was not statistically significant (p=0.097) and EF categories differed between the groups (p=0.04). Operative duration was longer in ONCABG, with 10 patients in the 251-330-minute category compared with none in OPCABG (p<0.001). POAF occurred during postoperative days 1-2 and 3-4 in ONCABG, while OPCABG cases were reported mainly during days 3-4.

Postoperative electrolyte abnormalities were more frequent in ONCABG. Lower potassium levels of 1.5-2.9 mEq/L were observed in 66.7% *vs.* 20.0% (p=0.011), while lower magnesium levels of 0.5-1.5 mg/dl occurred in 73.3% *vs.* 20.0% (p=0.004). Amiodarone use was higher in ONCABG (73.3% *vs.* 20.0%; p=0.004). ICU stay was also prolonged in the ONCABG group, with 73.3% remaining in ICU for 7-10 days compared with 13.3% in OPCABG (p=0.001). Overall, ONCABG showed a greater burden of POAF, inflammatory abnormalities, electrolyte disturbances, antiarrhythmic treatment and prolonged ICU stay compared with OPCABG in this study.

Discussion

The present comparative study included 30 CABG patients, with 15 in the ONCABG group and 15 in the OPCABG group. The study assessed POAF in relation to demographic, clinical, inflammatory, cardiac and postoperative variables. Overall, important differences were observed between the two surgical techniques.

Age distribution differed significantly between groups (p<0.001), while sex distribution was not significant (p=0.275). Hypertension was more frequent in ONCABG but was not significant (p=0.54), whereas diabetes was significantly higher in ONCABG patients (80% *vs.* 40%, p=0.026). These factors may contribute to POAF through inflammation, atrial remodeling and metabolic disturbances. Inflammatory markers were significantly higher in ONCABG. CRP (p=0.001) and IL-6 (p<0.001) were markedly elevated, while WBC was higher but not statistically significant (p=0.097). These findings support the role of CPB-induced systemic inflammation in postoperative atrial instability. Reduced EF was more frequent in ONCABG, although statistical significance was not established. Operative duration was also significantly longer in ONCABG (p=0.04).

The incidence of POAF was significantly higher in ONCABG, occurring in 11 patients (73.3%) compared with 5 patients (33.3%) in OPCABG (p<0.001). POAF also

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occurred earlier in the ONCABG group (p=0.028). This may be related to CPB-associated inflammation, myocardial stress and metabolic disturbances. Electrolyte abnormalities were significantly more common in ONCABG, with lower potassium (66.7% *vs.* 20%, p=0.011) and magnesium levels (73.3% *vs.* 20%, p=0.004). Amiodarone use was also higher in ONCABG (73.3% *vs.* 20%, p=0.004), likely reflecting the greater POAF burden rather than causing it. ICU stay was significantly longer in ONCABG (p=0.001), with 73.3% requiring 7-10 days compared with 13.3% of OPCABG patients. Overall, OPCABG was associated with a lower POAF burden, reduced inflammatory response and shorter ICU stay.

Conclusion

This comparative study found that postoperative atrial fibrillation occurred more frequently after on-pump CABG than after off-pump CABG. ONCABG was also associated with higher CRP and IL-6 categories, more frequent potassium and magnesium abnormalities, longer operative duration, greater amiodarone use and prolonged ICU stay. OPCABG demonstrated more favourable postoperative rhythm and ICU outcomes in this cohort. Early rhythm surveillance, correction of electrolyte abnormalities and timely management of POAF may support postoperative recovery. Larger, adequately powered studies are required to confirm the observed associations and determine their independent predictors.

Ethics Approval

The thesis reports institutional ethical approval and was conducted at Sree Balaji Medical College and Hospital. Patient confidentiality was maintained and no identifying information is included in this manuscript.

Conflict of Interest

The author declares no conflict of interest.

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