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COMPARATIVE ANALYSIS OF POST OPERATIVE ARRHYTHMIAS, AMONG PATIENTS UNDERGOING OFF-PUMP VERSUS ON-PUMP CORONARYARTERY BYPASS GRAFTING

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ABSTRACT

Background: *This study addresses the need for a comprehensive evaluation of outcomes in coronary artery bypass grafting (CABG) procedures, specifically comparing the on-pump and off-pump techniques. Recognizing the evolving landscape of cardiac surgery, understanding the implications of these methods is crucial for optimizing patient care.*

Methodology: *A retrospective analysis was conducted on a cohort of patients who underwent CABG, categorizing them based on whether on-pump or off-pump techniques were employed. Patient records were scrutinized for the occurrence of postoperative arrhythmias, length of hospital stay, and mortality rates. Statistical analyses were applied to discern significant differences between the two surgical approaches.*

Results*: The study revealed notable variations in postoperative outcomes between on-pump and off-pump CABG. The incidence of arrhythmias, length of hospital stay, and mortality rates were distinct in each group. These findings shed light on the potential advantages and drawbacks associated with each method, informing future surgical decisions and patient management.*

Conclusion: *In conclusion, our comparative analysis underscores the importance of tailoring CABG approaches to individual patient profiles. The study provides valuable insights into the nuanced outcomes of on-pump and off-pump techniques, facilitating evidence- based decision-making for cardiac surgeons and enhancing the overall quality of care for patients undergoing coronary artery bypass grafting.*

INTRODUCTION

Coronary-artery bypass grafting (CABG) is a procedure in which autologous arteries or veins are used as grafts to bypass coronary arteries that are partially or completely obstructed by atherosclerotic plaque. CABG is among the most commonly performed major surgical procedures, with approximately 400,000 operations performed annually in the United States [1]

.Furthermore, cardiac surgery has advanced to a point where mortality rates have declined dramatically either with the use of cardiopulmonary bypass(on-pump CABG) or without such bypass (off-pump CABG) [2].

During the past 30 years, coronary-artery bypass grafting (CABG) primarily was performed with the use of cardiopulmonary bypass ("on pump") with cardioplegic arrest, provides a surgical field free of motion and blood, allowing safe construction of the anastomoses. Historically, on- pump CABG was shown to improve ischemic symptoms and, in selected patients, prolong survival [3]. In the mid-1990s, interest emerged in performing CABG without the use of cardiopulmonary bypass (off pump), in order to reduce postoperative complications associated with the use of cardiopulmonary bypass,[4] including generalized systemic inflammatory response,[5] cerebral dysfunction,[6] myocardial depression, and hemodynamic instability [7].

Arrhythmias are a known complication after cardiac surgery and represent a major cause of morbidity, increased length of hospital stay, and economic costs. Atrial tachyarrhythmia is the most common postoperative heart rhythm disorder. Ventricular arrhythmias and brady- arrhythmias are less frequent [8]. Most frequent postoperative rhythm disturbances occur usually two to three days after surgery, mostly benign and self-terminating. Postoperative arrhythmias are associated with prolonged hospital stay and hemodynamics instability.

The following risk factors were considered: age, sex, type of heart disease, preoperative left ventricular ejection fraction, cardiopulmonary bypass time and aortic clamping duration and inotropic support [9]. Surgery related risk factors that cause post op arrhythmias include; trauma, inflammation, hemodynamic stress, [10] ischemic injury, [11] perioperative drugs, [12] and electrolytes disorders [13]. The use of cardiopulmonary bypass(CPB), the influence of cardioplegia and myocardial ischemia are possible factors responsible for postoperative occurrence of AF [14].

Atrial fibrillation is a common complication after cardiac surgery, affecting about 10% to 40% of patients undergoing CABG. This arrhythmias occurs most frequently in the first five days of the postoperative period, peaking between 24 and 72 hours, being uncommon after the first week [15]. However, some studies reported no relevant difference in the incidence of this arrhythmia regarding the use or not of CPB. Post-op AF has been reported in 25-60% of patients depending on the type of cardiac surgery performed in international literature [16]. Some patients are clearly at risk for ventricular arrhythmias as which are uncommon but serious complication. Ventricular arrhythmias, including VT and VF, can occur after cardiac surgery which is generally lower than AF, with an incidence of 2-5% in some studies [17]. Post op AF was associated with greater in-hospital mortality and prolonged hospital stays [18].

Our research tackles a crucial question in heart surgery: which is the better method, off-pump or on-pump coronary artery bypass grafting (CABG), in terms of post-surgery issues like arrhythmias, length of stay in the hospital, and survival rates? We're also using the most recent data to make our findings relevant to today's medical practices. Comparative analysis of post- operative outcomes in off-pump versus on-pump Coronary Artery Bypass Grafting (CABG) holds paramount significance in clinical practice for giving doctors the valuable information to make smart choices about which CABG method to use, ultimately improving patient care. This research advances medical knowledge, fostering quality, improvement initiatives and influencing the development of standardized protocols for CABG procedures. Our perspective highlights a nuanced consideration of off-pump and on-pump CABG procedures. Ultimately, the choice between the two techniques should be based on a comprehensive assessment of patient-specific factors and the surgeon's expertise, aiming for the best possible outcome in each individual case. Our research aims to fill important gaps in our knowledge and give a complete view of which CABG method is best, helping doctors make better decisions and improving patient care overall.

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II- Literature review:

The study conducted by Arslan et al. (2021), the focus was on investigating the incidence of postoperative atrial fibrillation (POAF) in patients who underwent coronary artery bypass grafting (CABG) either on-pump

or off-pump. This retrospective analysis of 3,197 patients revealed significant insights into the factors contributing to POAF. The findings underscored several independent predictors of POAF after CABG, including the type of operation, the number of anastomoses, specific arterial grafts, vasopressor therapy, and duration of the operation, age, hypertension and length of hospital stay. The study concluded that the utilization of off-pump CABG in selected cases as a strategy to minimize the risk of POAF. The study concluded that the utilization of off-pump CABG in selected cases as a strategy to minimize the risk of POAF. It provided valuable data for cardiac surgeons and researchers, helping them optimize patient outcomes after CABG [19].

In the field of coronary artery bypass grafting (CABG), the choice between on-pump coronary artery bypass grafting (ONCAB) and off-pump coronary artery bypass grafting (OPCAB) has been a topic of extensive research. Kirmani et al.'s (2019) comprehensive analysis, covering a significant cohort of 10,293 patients, formulated on this ongoing debate. The study showed that a specific type of heart surgery called OPCAB had better results. Patients who had OPCAB not only had fewer problems during their hospital stay but also lived longer - up to 10 and 15 years after the surgery. The study supported OPCAB as a good and beneficial choice for heart surgery [20]. The continual analysis between on-pump coronary artery bypass graft (ONCABG) and off- pump coronary artery bypass graft (OPCABG) techniques has been pivotal in cardiovascular surgery field.

The study conducted by Ibrahim at al. (2020) contributes significantly to this discourse by focusing on intensive care unit (ICU) length of stay and mortality rates. By analyzed the data of 1569 patients, the research sheds light on crucial aspects of postoperative recovery. The study
showed that patients who had OPCAB stayed in the ICU much longer than those who had ONCABG. Furthermore, the study's confirmation of comparable mortality rates between the two techniques provides a vital piece of information for clinicians and researchers [21].

The study conducted by Numata et al. (2022) provides valuable insights into the long-term outcomes of off-pump coronary artery bypass (OPCAB) compared to on-pump coronary artery bypass (ONCAB) in Japan. Utilizing the Japan Adult Cardiovascular Surgery Database, the research focused on 7724 matched cases from 41 institutions. The results revealed significant early benefits for OPCAB, including lower in-hospital mortality and reduced stroke rates. However, in the long term, particularly for patients over 75 years old or those with incomplete revascularization, OPCAB exhibited less favorable outcomes [22].

The study by Ismael et al. (2022) experience into a crucial comparison in cardiac surgery: off- pump coronary artery bypasses grafting (CABG) versus on-pump CABG. This prospective randomized study, conducted between August 2017 and July 2019, aimed to evaluate the efficiency and safety of both procedures. Notably, the research found that off-pump CABG demonstrated advantages in terms of reduced operation time, lower need for cardiac inotropes, and decreased postoperative complications related to cardiopulmonary bypass. Additionally, patients in the off-pump group experienced shorter ventilation time and ICU stay. Although both techniques showed comparable results in the six months' postoperative follow-up, the study emphasized the importance of surgical expertise, suggesting that excellent outcomes could be achieved with both methods when performed by skilled surgeons [23].

The study conducted by Phothikun et al. (2023) provides valuable insights into the outcomes of different coronary artery bypass grafting (CABG) techniques: on-pump CABG (ONCAB), and off-pump CABG (OPCAB)). Their retrospective observational cohort of 2,028 patients compared short- and long-term results of these techniques. Notably, OPCAB demonstrated the lowest postoperative ischemic injury, indicated by lower cardiac enzyme levels. Long-term analysis revealed a 10-year survival rate of 80.5% for OPCAB and ONCAB (73.7%). OPCAB was associated with significantly reduced mortality risk and major adverse cardiovascular events (MACE), making it a preferable and beneficial technique for long-term outcomes. These findings emphasize the advantages of OPCAB in terms of postoperative complications and highlight its potential as a favorable choice in CABG procedures [24].

Stone et al. focused on comparing the incidence of post-operative atrial fibrillation (POAF) in patients receiving carvedilol and metoprolol after off-pump coronary artery bypass graft (CABG) surgery. The research, conducted in a single-center retrospective review, involved 134 adult patients. Results indicated

that POAF occurred in 5.8% of patients in the carvedilol group, significantly lower than the 24.0% in the metoprolol group. Carvedilol was associated with a reduced risk of POAF (odds ratio 0.17, p = 0.023). Additionally, safety analyses demonstrated that carvedilol was safer, with a lower incidence of bradycardia compared to metoprolol-treated patients. Time-to-event analyses further supported the advantage of carvedilol, showing a reduced hazard ratio for POAF with carvedilol use. This study suggests that carvedilol might be more effective and safer than metoprolol in preventing POAF after off-pump CABG, providing valuable insights for clinicians in selecting appropriate medications for their patients undergoing cardiac surgery [25].

Aranda-Michel et al. investigated the outcomes of redo coronary artery bypass grafting (CABG) procedures performed either on-pump or off-pump. Analyzing 350 patients undergoing redo CABG between 2011 and 2017, the study found comparable short and long-term survival rates between the two techniques. Interestingly, while blood product transfusion and new-onset atrial fibrillation were higher in the on-pump group, there were no significant differences in 30-day, 1- year, or 5-year mortality between off-pump and on-pump redo CABG. However, the off-pump group had a higher 5-year all-cause readmission rate. The study concluded that both techniques were viable and safe options for redo CABG, suggesting that the choice between on-pump and off-pump procedures could be made based on the surgeon's experience [26] .

The systematic review conducted by Shaefi et al. delves into the comparison between off-pump coronary artery bypass grafting (OPCAB) and traditional on-pump CABG procedures. Despite the theoretical advantages of OPCAB, such as reduced perioperative complications, several high- quality clinical trials have shown no significant long-term benefits over traditional CABG. While OPCAB does reduce the need for blood transfusion and shortens hospital stays, it poses challenges related to effective myocardial revascularization. The study suggests that OPCAB might be a safe alternative for patients with low baseline risk or specific anatomical limitations. However, due to its technical challenges and lack of substantial long-term benefits, OPCAB has seen a decline in popularity. The diminishing utilization of OPCAB worldwide, coupled with the decreasing expertise in this technique, poses challenges for future trials. Nevertheless, OPCAB remains a viable option for revascularization in cases where the use of cardiopulmonary bypass is not feasible [27].

Demirdaş et al. (2019), a retrospective analysis was performed on 1672 patients who underwent coronary artery bypass grafting (CABG) between October 2014 and August 2016. The study aimed to evaluate the clinical outcomes of patients undergoing off-pump and on-pump CABG. Among the enrolled patients, 783 underwent off-pump CABG and 889 underwent on-pump CABG. The comparison revealed several significant differences between the two groups. In the off-pump CABG group, there were fewer bypasses to coronary arteries, a lower incidence of postoperative atrial fibrillation, shorter intubation time, reduced duration of intensive care unit stay and hospital stay, decreased need for re-exploration, and lower usage of vasopressor and positive inotropic drugs. Additionally, the off-pump group had lower total drainage, reduced blood and blood product usage, and a lower mortality rate. These findings suggest that off-pump CABG offers several advantages, making it a favorable option for selected patients with coronary artery disease [28].

Rational discussion:

The rationale for this topic lies in its potential to improve patient outcomes, surgical practices and contribute to the ongoing discussion regarding the choice between on pump and off pump. It has real word implications for patient care, healthcare resources and clinical guidelines, making it a valuable area of medical research.

Aims

To investigate the incidence and severity of postoperative arrhythmias in patients who underwent off-pump CABG compared to those who had on-pump CABG.

Objectives

1.To assess arrhythmias, length of ICU stay, mortality rate among patients under using pre- structured Performa.

2.To compare the arrhythmias, length of ICU stay, mortality rate among patients under using pre-structured Performa.

III- MATERIALS AND METHODS METHODOLOGY:

The study was designed as an observational study conducted to examine the post-operative complications in adult patients undergoing coronary artery bypass grafting (CABG). The research took place at two hospitals: the Rawalpindi Institute of Cardiology in Rawalpindi and Farooq Hospital in Islamabad. The study employed a pre-structured performa as the research tool to collect data. The data was gathered over a period of three months, with a sample size of 100 patients.

Non-randomized convenient sampling technique was used for patient selection, with specific inclusion and exclusion criteria. The inclusion criteria consisted of all adult CABG patients with a left ventricular ejection fraction (LV EF) greater than 40%, who were undergoing on-pump or off-pump CABG. Exclusion criteria included patients who had valvular surgery, pediatric heart surgery patients, those with congenital cardiac surgeries, and pre-operative arrhythmic patients.

Data collection was conducted using a pre-structured performa, which included various parameters such as arrhythmias, the length of ICU stay, and mortality rates. The collected data was entered into the SPSS 26 statistical software for analysis. Descriptive statistics were used to represent the mean and standard deviation of continuous variables, while categorical variables were represented as frequencies and percentages. The comparison between the two groups, in terms of post-operative complications like arrhythmias, lengthy hospital stays, and mortality, was done using an independent t-test. A p-value of less than 0.05 indicated statistical significance. Additionally, chi-square tests were employed to assess categorical variables causing post-operative complications, and correlation analysis was conducted to assess continuous variables influencing these complications.

IV- RESULTS AND DISCUSSION

4.1: TABLES

Table 1: Age

		TYPE_CABG		
		On-pump	**Off-pump**	**Total**
AGE	< 50 years	24%	28%	26
	>50 years	76%	72%	74
Total		50	50	100

Table 1 illustrate that age is divided into two groups, one group includes patients >50 and second group includes patients <50. About 38 patients on on-pump and 36 patients on off-pump are above than 50 years of age.

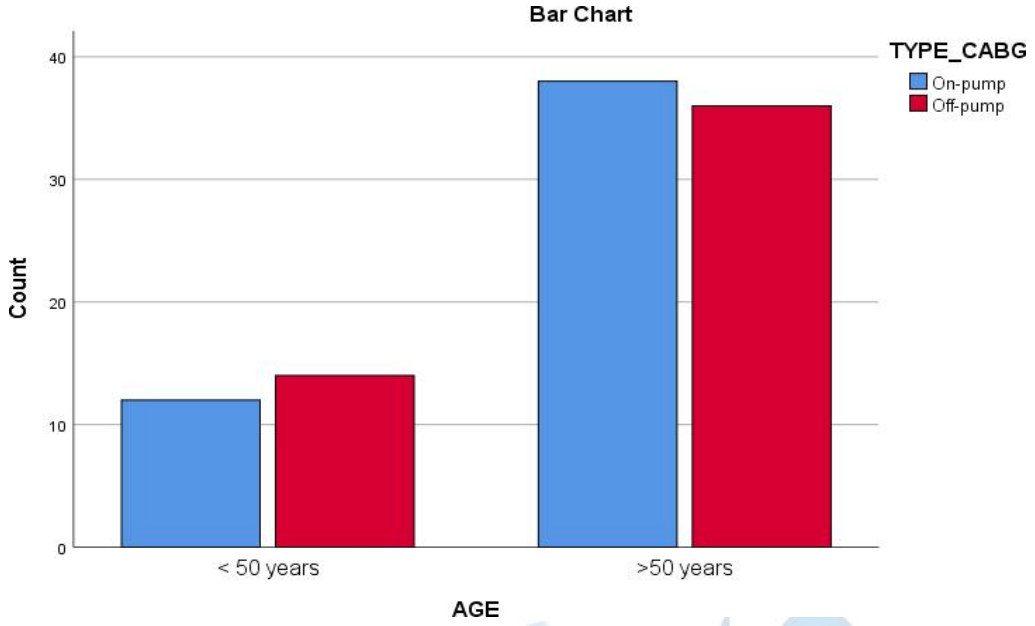

Table 2: Gender

		TYPE_CABG		
		On-pump	**Off-pump**	**Total**
GENDER	Male	40	36	76
	Female	10	14	24
Total		50	50	100

According to this table, out of the 100 patients who had CABG surgery, 24 were female and 76 were male. Compared to women, more men had both on pump and off pump procedures performed

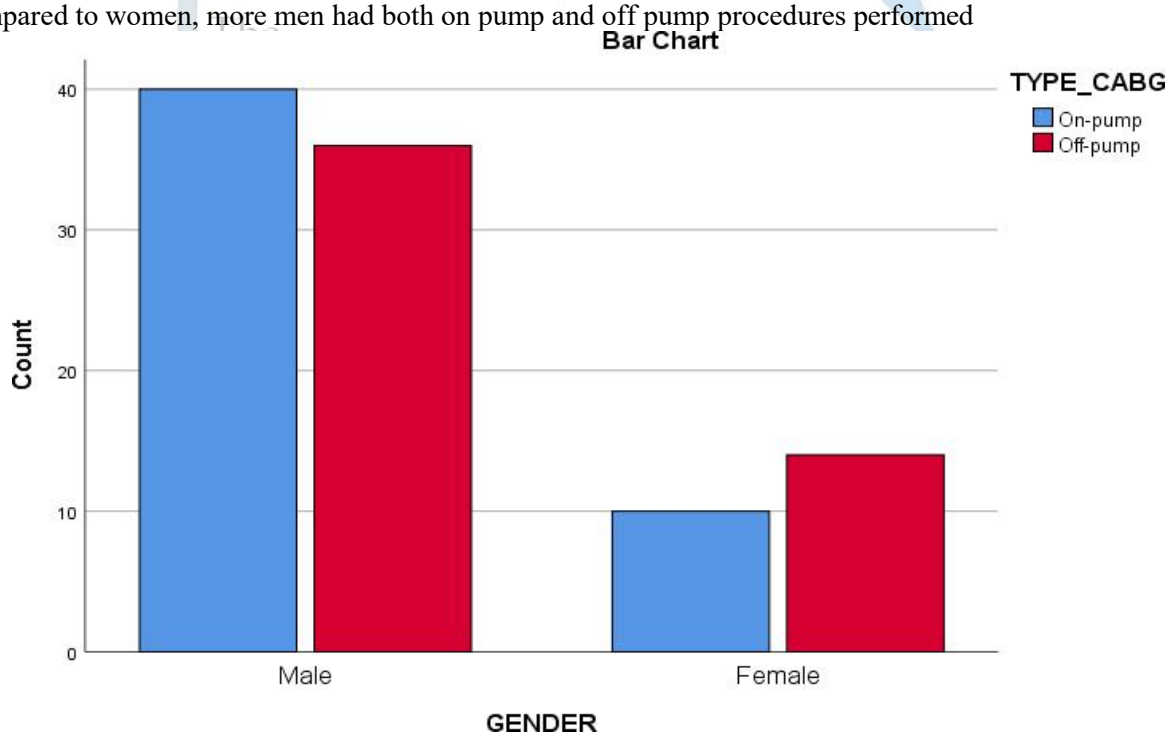

Table 3: Ejection fraction

		TYPE_CABG		
		On-pump	**Off-pump**	**Total**
EF	Normal EF	21	21	42
	MILD EF	25	27	52
	SEVERLY REDUCED EF	4	2	6
Total		50	50	100

This table explains how the EF category distribution varied between CABG patients receiving on-pump and off-pump care. Although 42% of patients in both groups had normal EF, a considerably higher proportion of off-pump patients (54% vs. 50% for on-pump) had mildly decreased EF. However, the incidence of severely dropped EF (6% in both groups) was nearly same.

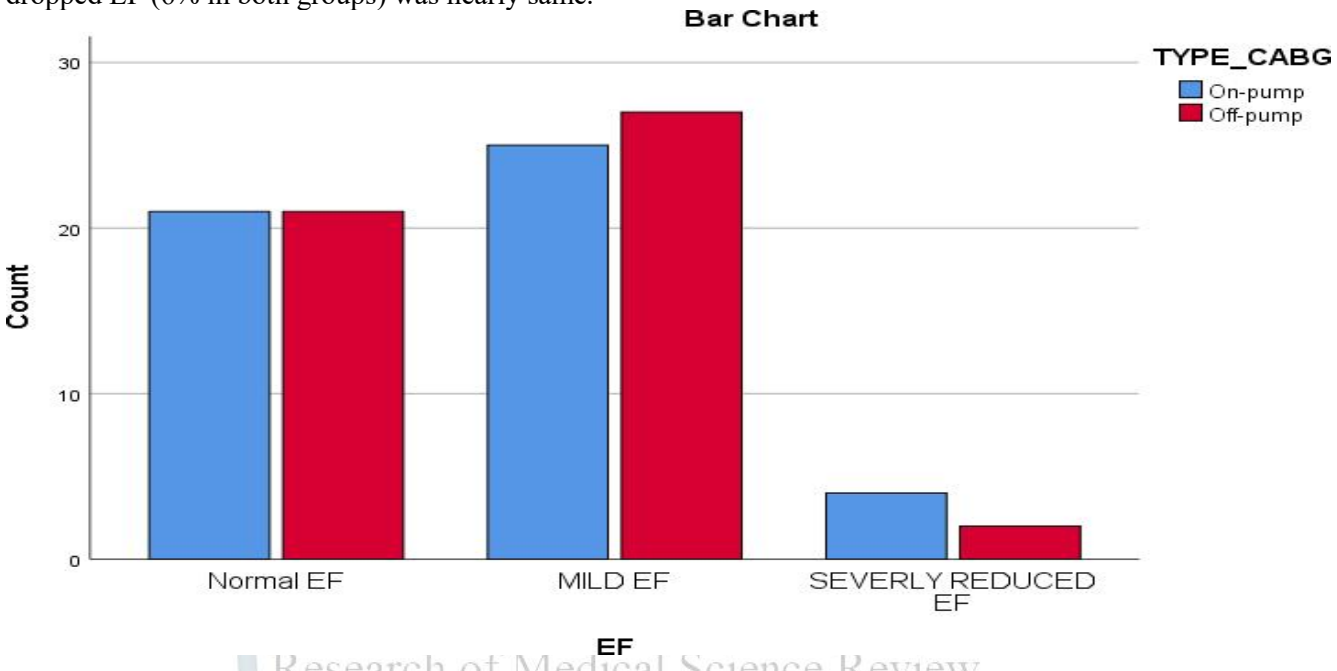

Table 4: Diabetics

		TYPE_CABG		
		On-pump	**Off-pump**	**Total**
DIABETIC	NO	28	31	59
	YES	22	19	41
Total		50	50	100

The number of patients who had CABG operation is displayed in this table, with the patients' diabetes status being categorized. Out of the 100 patients who underwent CABG, 41 had diabetes and the remaining 59 did not. The majority of diabetic patients underwent CABG on-pump.

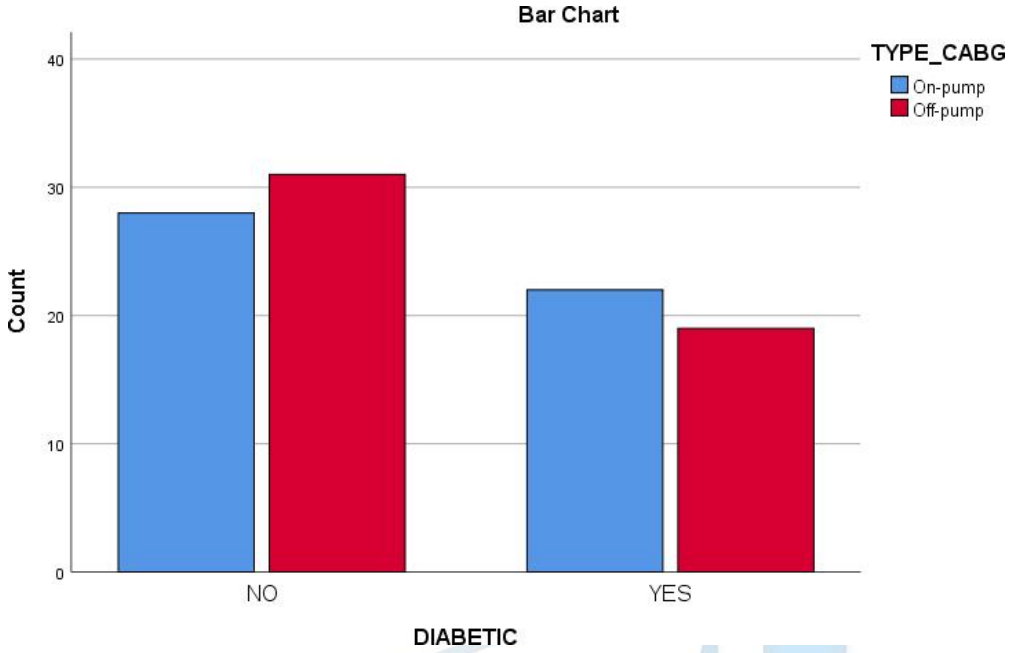

Table 5: Hypertension

		TYPE_CABG		
		On-pump	**Off-pump**	**Total**
HYPERTENSION	NO	20	11	31
	YES	30	39	69
Total		50	50	100

This table shows that compared to on-pump CABG surgery, hypertension is more common in off-pump cases. A total of 70% of the 100 patients who had off-pump surgery experienced hypertension, compared to only 60% of those in the on-pump group. This suggests that off-pump CABG and pre-existing hypertension may be associated.

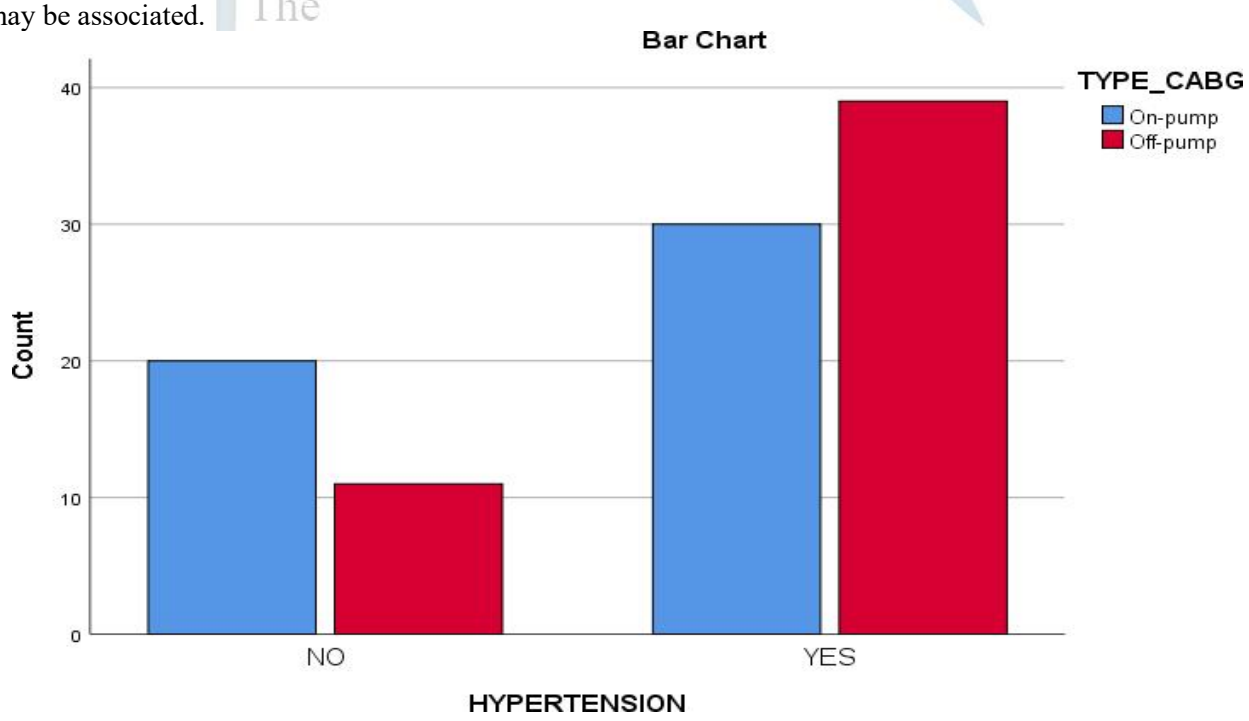

Table 6: Smoking

		TYPE_CABG		
		On-pump	**Off-pump**	**Total**
SMOKING	NO	22	25	47
	YES	28	25	53
Total		50	50	100

This table displays the data for 100 patients, of whom 56% were smokers who had on-pump CABG procedures, and 50% were non-smokers who had off-pump procedures. It clarifies that there are some associations between smoking and on-pump.

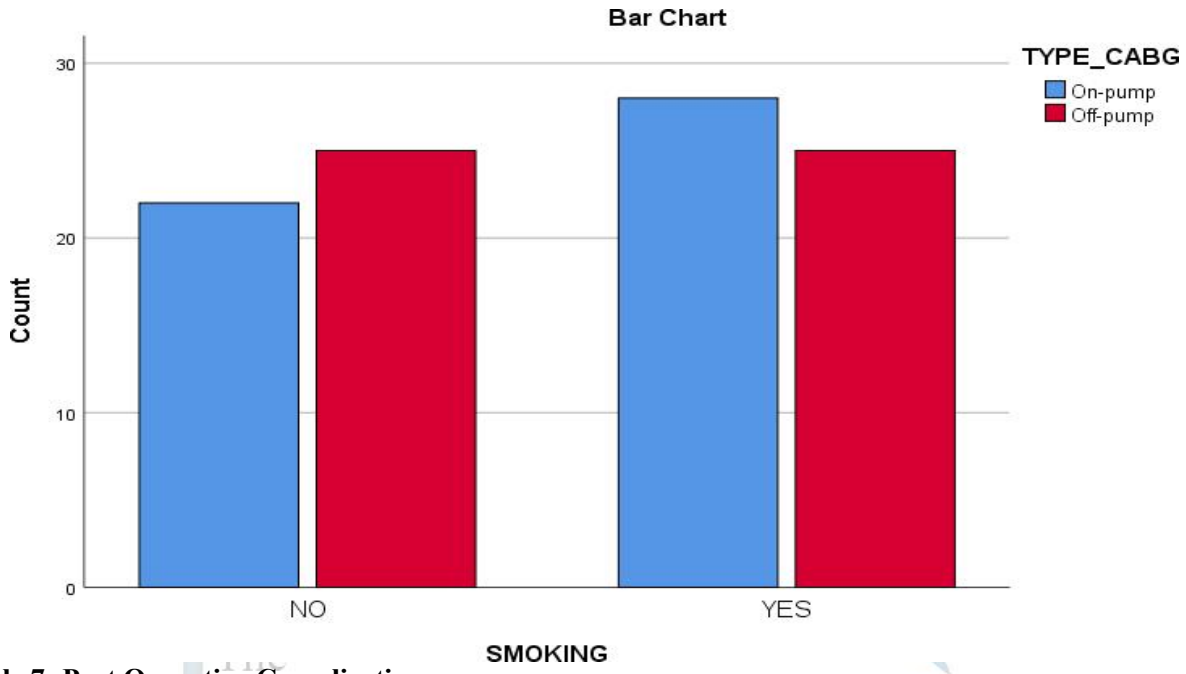

Table 7: Post Operative Complications

	Off-pump	**On-pump**	**P value**
	Mean ±SD	**Mean ±SD**	
ARRYTHMIAS	.36 ±.485	.46 ±.503	.314
MORTALITY	.02 ±.141	.14 ±.351	027
ICU_STAY	.30 ±.463	.52 ±.505	.025

Out of 100 patients mean value for arrhythmias is .46 in on pump while for off pump is .36 and P value greater than 0.05.This shows that arrhythmias are not significant and associated with on pump. . Out of 100 patients mean value for mortality is .14 in on pump while for off pump is .02 and P value is also less than 0.05.This shows significant association of mortality with on pump. Out of 100 patients mean value for ICU stay in on pump cases is .52 while for off pump is .30 and P value is also less than 0.05.This shows significant association of longer ICU stay with on pump.

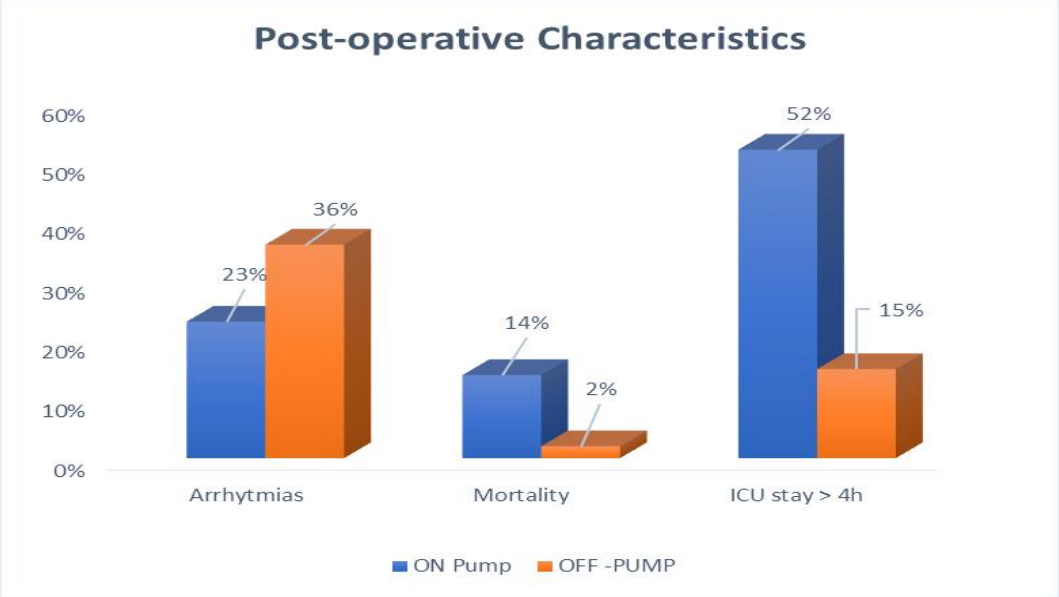

Table 8: Frequency of post-op complications with Type of CABG

	On-pump		Off-pump		Total	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**
ARRYTHMIAS	23	27	18	32	41	59
MORTALITY	7	43	1	49	8	92
ICU_STAY	26	24	15	35	41	59

Out of 100 patients, 23 patients on on-pump and 18 patients on off-pump experienced arrhythmias. Out of 100 patients, only 1 patient experienced mortality in on-pump while on off- pump, strength was 7. Out of 100 patients, 26 had experienced ICU-stay more than normal duration on on-pump while on off-pump, strength was 15.

Discussion:

Our study aimed to investigate the impact of Off-Pump and On-Pump Coronary Artery Bypass Grafting (CABG) on three critical postoperative outcomes: arrhythmias, length of hospital stays, and mortality.

The results of our study indicate that there is no significant difference in the occurrence of postoperative arrhythmias between the On-pump and Off-pump groups ($p > 0.05$). This finding suggests that the choice between on-pump and off-pump CABG procedures may not significantly impact the incidence of arrhythmias in the postoperative period.

The incidence of post-operative atrial fibrillation was significantly lower in the off-pump group. Although this was the result of the pooled data analysis, it should be noted that some studies showed no difference in the incidence of post-operative atrial fibrillation [29]. Atrial fibrillation is not a life-threatening occurrence, though its presence could predispose to hemodynamic compromise, thromboembolic events, anxiety and increased costs [30]. One of the primary reasons why off-pump CABG may elicit less atrial fibrillation is that it avoids atrial cannulation [31].

The results reveal a statistically significant association between the type of CABG and length of hospital stay ($p < 0.05$). Notably, patients who underwent Off-pump CABG demonstrated a shorter length of hospital stay compared to their On-pump counterparts. Our analysis also supported by Demirdaş et al.'s (2019) retrospective analysis revealed several advantages of off- pump CABG, including fewer bypasses, lower incidence of POAF, shorter intubation time, reduced ICU and hospital stay, decreased need for re-exploration, lower usage of vasopressors and positive inotropic drugs, lower total drainage, reduced blood product usage, and a lower mortality rate.

In many studies, there has been mentioned that OPCABG shortens hospital of ICU LOS. Studies that support the statement are those conducted by Islam et al [31] and Brewer et al [32]. Both studies mention that the off-pump technique shortens the course of treatment in hospitals and ICUs. Nonetheless, the study never discusses why off-pump can shorten the length of stay. In contrast, our study found that the length of stay in OPCABG patients was longer than in ONCABG patients.

The degree to which a patient tolerates the CABG treatment, the natural course of the disease, the procedural complexity, and the postoperative recovery are all factors that influence mortality [33]. In this scenario, post-CABG mortality is linked to complications following the surgery, and ONCABG is the most common cause of these issues). The Off-pump group exhibits a notably lower mortality rate compared to the On-pump group [34].

Our result was supported by many previous studies; Ismaiel et al.'s (2022) prospective randomized study emphasized the efficiency and safety of both on-pump and off-pump CABG, with off-pump showing advantages in terms of reduced operation time, lower need for cardiac inotropes, and decreased postoperative complications [23]. Phothikun et al.'s (2023) retrospective cohort study further supported off-pump CABG, demonstrating lower postoperative ischemic injury and improved long-term survival rates compared to on-pump CABG [24].

V- CONCLUSIONS AND RECOMMENDATIONS

Our study is showing that there are more post-op complications on on-pump in comparison with off-pump. Our research is supporting off-pump CABG technique to reduce post-op complications. Arrhythmias, longer duration of ICU-stay and mortality was lower in off-pump CABG.

Implications

Our findings provide compelling evidence for the potential benefits of off-pump CABG over on- pump in terms of reducing mortality and ICU length of stay. This suggests that off-pump should be considered a preferred surgical approach for appropriate patients undergoing CABG, particularly those with high risk profiles. However, the lack of significant difference in post- operative arrhythmias warrants further investigation to clarify the underlying mechanisms and identify potential preventative strategies.

Future directions

While this study strengthens the evidence for off-pump CABG's impact on mortality and ICU stay, additional research is crucial to gain a deeper understanding of arrhythmic patterns in both on-pump and off-pump procedures. Future studies could explore specific pre-operative factors and intraoperative strategies associated with arrhythmic risk to optimize patient management and improve post-operative outcomes

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