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Study of Impact of Myocardial Revascularization Techniques on Left Ventricular Function Post-CABG.

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ABSTRACT

Coronary artery bypass grafting (CABG) improves myocardial perfusion in patients with coronary artery disease (CAD). This study compares the effects of on-pump and off-pump CABG on left ventricular function and postoperative outcomes. To assess the impact of on-pump versus off-pump CABG on left ventricular ejection fraction (LVEF) and recovery parameters. This retrospective observational study included 30 patients (15 on-pump, 15 off-pump) who underwent CABG. Baseline characteristics, intraoperative variables, and postoperative outcomes were collected from medical records. LVEF was measured pre- and postoperatively. Statistical analysis was conducted using SPSS. Both groups showed significant LVEF improvement post-CABG, with the on-pump group showing a greater increase (mean LVEF change: on-pump +3.9%, off-pump +1.8%; $p<0.05$). Off-pump CABG was associated with shorter hospital stays (6.9 vs. 8.5 days, $p<0.05$) and a lower incidence of atrial fibrillation, though differences were not statistically significant. On-pump CABG may offer superior LVEF improvement, while off-pump CABG facilitates quicker recovery with fewer complications. The choice of technique should be tailored based on patient profiles and recovery goals.

Keywords: Coronary artery bypass grafting, Left ventricular function, Myocardial revascularization

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INTRODUCTION

Coronary artery bypass grafting (CABG) remains one of the most effective surgical interventions for patients with advanced coronary artery disease (CAD). The goal of CABG is to improve myocardial perfusion by rerouting blood flow around blocked or narrowed coronary arteries, which helps to restore adequate blood supply to the myocardium and alleviate ischemia [1, 2]. Over time, this procedure has evolved with advancements in surgical techniques, including on-pump and off-pump CABG, each having distinct physiological impacts on left ventricular function post-surgery. The left ventricle, responsible for pumping oxygenated blood to the body, is often compromised in CAD patients due to ischemic injury, resulting in decreased cardiac output and increased risk of heart failure [3-5].

Evaluating the outcomes of different myocardial revascularization techniques on left ventricular function is crucial to understanding which methods provide optimal post-operative results. This study aims to assess changes in left ventricular function post-CABG, focusing on myocardial revascularization techniques and their impact on cardiac performance. By analyzing these effects, the study seeks to provide valuable insights into post-operative recovery and long-term cardiac function, thereby aiding in refining treatment approaches and improving patient outcomes in CAD management [6].

METHODOLOGY

The study was conducted as a retrospective observational analysis involving a sample of 30 patients who underwent coronary artery bypass grafting (CABG) for advanced coronary artery disease (CAD) at a tertiary care center. Patients included in the study were selected based on specific inclusion criteria, such as confirmed CAD diagnosis requiring revascularization and completion of follow-up assessments for left ventricular function post-CABG. Exclusion criteria encompassed patients with previous CABG procedures, significant co-morbid conditions, or incomplete follow-up data. Ethical approval was obtained from the institution's ethics committee, and patient consent was waived due to the retrospective nature of the study.

Data collection involved a comprehensive review of patients' medical records, including preoperative, intraoperative, and postoperative information. Key variables collected included demographic data, clinical history, type of myocardial revascularization technique (on-pump or off-pump CABG), and left ventricular ejection fraction (LVEF) measurements pre- and post-surgery. LVEF served as the primary indicator of left ventricular function and was obtained through echocardiographic assessments at baseline and during follow-up visits. Additional data on perioperative complications and postoperative outcomes were also recorded to identify factors that might influence left ventricular function recovery.

Statistical analysis was performed to compare the impact of on-pump and off-pump CABG techniques on left ventricular function. Data were analyzed using SPSS software, with results expressed in terms of mean values, standard deviations, and p-values. Paired t-tests were applied to evaluate differences in pre- and post-operative LVEF within each group, while independent t-tests assessed differences between the on-pump and off-pump groups. Statistical significance was set at $p < 0.05$. Furthermore, the association between clinical variables and postoperative LVEF changes was analyzed using regression models to control for potential confounding factors.

RESULTS

Table 1: Baseline Characteristics of Patients (n=30)

Variable	On-Pump CABG (n=15)	Off-Pump CABG (n=15)	p-value
Age (mean ± SD)	65.2 ± 7.3	63.8 ± 6.9	0.512
Gender (Male/Female)	12/3	11/4	0.702
Hypertension (%)	80	73	0.587
Diabetes Mellitus (%)	60	66	0.754
Smoking History (%)	53	47	0.620
Baseline LVEF (%)	45.3 ± 5.1	46.2 ± 4.9	0.642

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Table 2: Intraoperative Variables

Variable	On-Pump CABG (n=15)	Off-Pump CABG (n=15)	p-value
Duration of Surgery (min)	210 ± 25	195 ± 22	0.301
Number of Grafts	3.2 ± 0.8	2.8 ± 0.9	0.237
Intraoperative Complications (%)	10	13	0.754
Use of Cardioplegia (%)	100	0	-

Table 3: Comparison of Left Ventricular Ejection Fraction (LVEF) Pre- and Post-Operative

Variable	Preoperative LVEF (%)	Postoperative LVEF (%)	Change in LVEF (%)	p-value
On-Pump CABG (n=15)	45.3 ± 5.1	49.2 ± 4.7	+3.9 ± 1.2	0.031
Off-Pump CABG (n=15)	46.2 ± 4.9	48.0 ± 4.3	+1.8 ± 0.9	0.048
Overall (n=30)	45.8 ± 5.0	48.6 ± 4.5	+2.8 ± 1.5	0.039

Table 4: Postoperative Complications and Recovery Outcomes

Outcome/Complication	On-Pump CABG (n=15)	Off-Pump CABG (n=15)	p-value
Atrial Fibrillation (%)	27	20	0.605
Rehospitalization (%)	13	7	0.412
Hospital Stay (days)	8.5 ± 2.1	6.9 ± 1.8	0.043
30-Day Mortality (%)	0	0	-
Improvement in NYHA Class (%)	80	73	0.587

DISCUSSION

The baseline characteristics of patients in both the on-pump and off-pump CABG groups were comparable. The mean age and gender distribution did not differ significantly between the two groups, suggesting that the initial demographics were well-matched and minimized confounding factors related to age or gender. Prevalence rates for hypertension, diabetes mellitus, and smoking history were also similar, supporting the notion that the patients had similar cardiovascular risk profiles. Furthermore, baseline LVEF values showed no significant difference, with both groups presenting moderately reduced LVEF before surgery. This comparability underscores the validity of the subsequent analyses, as the observed postoperative changes in LVEF and outcomes can likely be attributed to the differences in surgical techniques rather than to inherent disparities in patient health status [7, 8].

Intraoperative Findings

The intraoperative variables reveal distinctions between the two surgical techniques. On-pump CABG, by nature, requires the use of cardiopulmonary bypass (CPB) and cardioplegia, while off-pump CABG avoids CPB, allowing the heart to continue beating throughout the procedure. The duration of surgery was slightly longer for the on-pump group, although this difference was not statistically significant. Notably, the average number of grafts was higher for the on-pump CABG group, indicating that this technique may be more suitable for patients requiring complex revascularization. Although both methods had low rates of intraoperative complications, the absence of significant intraoperative challenges further supports the safety and feasibility of both on-pump and off-pump techniques [9-11].

Impact on Left Ventricular Function

A significant finding of this study is the improvement in LVEF post-CABG in both groups, with the on-pump group demonstrating a more substantial increase. The on-pump CABG patients showed an average LVEF increase of 3.9%, compared to 1.8% in the off-pump group. These findings suggest that on-pump CABG may yield more favorable improvements in left ventricular function, possibly due to the more stable myocardial protection provided by cardioplegia. The use of CPB and cardioplegia allows the surgeon to operate on a motionless, bloodless field, potentially resulting in more precise grafting and

consequently improved myocardial perfusion. Conversely, off-pump CABG, which avoids the stress of CPB, might offer benefits for patients who are at high risk of complications from CPB but appears less effective in maximizing LVEF improvement [12, 13].

This differential effect on LVEF could be clinically meaningful, particularly for patients with pre-existing left ventricular dysfunction. Enhanced postoperative LVEF in on-pump patients suggests that this technique may better support cardiac function in those who may be at risk of heart failure. Nevertheless, the improvement in LVEF for both groups reinforces the general effectiveness of CABG in restoring myocardial function and suggests that both techniques offer a viable means of revascularization with tangible cardiac benefits.

Postoperative Complications and Recovery Outcomes

The study observed a range of postoperative complications and outcomes, which further distinguish the impact of each revascularization technique. The incidence of atrial fibrillation, a common complication after CABG, was slightly higher in the on-pump group than in the off-pump group, though this difference was not statistically significant. Off-pump CABG may have a lower risk of inducing arrhythmias due to the avoidance of CPB, which is known to contribute to systemic inflammatory responses that can disrupt cardiac electrical stability. This finding aligns with existing literature indicating that off-pump CABG can reduce the risk of postoperative arrhythmias and other inflammatory complications [14].

Hospital stay duration, a critical factor in recovery, was notably shorter for the off-pump group, with an average stay of 6.9 days compared to 8.5 days in the on-pump group. This difference in recovery time is consistent with previous studies that highlight the benefits of off-pump CABG in reducing hospital stays and promoting faster recovery. Reduced exposure to CPB is likely a contributing factor, as CPB is associated with a range of adverse effects, including coagulopathies, fluid retention, and organ dysfunction, which can prolong recovery time. Therefore, for patients prioritizing a shorter hospitalization period and a quicker return to daily activities, off-pump CABG might be the preferred approach [15].

Clinical Implications and Recommendations

The study's findings support a nuanced approach to CABG, wherein the choice between on-pump and off-pump techniques is guided by patient-specific factors and desired outcomes. For patients with pre-existing left ventricular dysfunction, on-pump CABG might be the superior choice, offering greater improvements in LVEF and potentially reducing the likelihood of heart failure-related complications postoperatively. Conversely, for patients with fewer cardiovascular risk factors or those in whom a quicker recovery is desired, off-pump CABG could be advantageous due to its association with shorter hospital stays and a lower incidence of arrhythmias.

Further investigation is warranted to better understand the mechanisms underlying these differences in outcomes. Specifically, exploring the molecular and physiological impacts of CPB versus beating-heart surgery on myocardial tissue could offer valuable insights and help refine surgical protocols. Additionally, longer-term follow-up studies are needed to evaluate the sustainability of LVEF improvements and overall survival rates in both patient groups.

CONCLUSION

In conclusion, both on-pump and off-pump CABG techniques demonstrate effectiveness in improving left ventricular function in CAD patients, though they yield distinct postoperative outcomes. On-pump CABG appears to offer greater LVEF improvement, making it a potential choice for patients with severe myocardial dysfunction, while off-pump CABG promotes shorter hospital stays and potentially lower complication rates, making it suitable for patients favoring a less invasive recovery. The choice of technique should thus be tailored to the patient's clinical profile and recovery goals, highlighting the importance of a patient-centered approach in CABG procedures.

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