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Early Outcomes of Coronary Artery Bypass Grafting in Patients with Recent Non-ST Segment Elevation Myocardial Infarction

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ABSTRACT

Background: Coronary artery disease (CAD) remains a major contributor to global mortality. Non-ST-segment elevation myocardial infarction (NSTEMI) is a high-risk acute coronary syndrome with increasing prevalence.

Aim: This research aimed to evaluate early results of coronary artery bypass grafting (CABG) in cases with recent NSTEMI in comparison with those undergoing elective CABG without myocardial infarction.

Patients and methods: This prospective, analytical case-control research involved 80 patients scheduled for isolated CABG at Kasr Al-Ainy Hospitals through the period from September 2024 to February 2025.

Results: Statistically insignificant variances were observed among the 2 groups according to gender, age, operative time, number of grafts, body mass index (BMI), cross-clamp time, Intensive Care Unit (ICU)/hospital stay duration, and postoperative complications such as arrhythmia, bleeding, stroke, or need for reoperation ($p > 0.05$). No mortality occurred in either group during the 30-day follow-up. Although NSTEMI patients had slightly longer cardiopulmonary bypass times, the differences were not significant.

Conclusion: Early CABG in patients with recent NSTEMI is associated with comparable short-term outcomes to those without prior MI. It can be considered a safe strategy in carefully selected patients.

Keywords: NSTEMI, CABG, Early outcomes, Postoperative complications.

INTRODUCTION

Cardiovascular diseases (CVDs) are the major cause of mortality worldwide, responsible for around 17.9 million mortalities annually [(1)]. Acute coronary syndromes (ACS) significantly contribute to CVD mortality. Yet assessments of the worldwide epidemiology of ACS are limited by lack of information [(2)]. In several countries, potentially a majority, comprehensive data on the prevalence of ACS is unavailable, and fundamental baseline characteristics are frequently absent. Data on the incidence and prevalence of ischemic heart disease (IHD) are accessible from the Global Burden of Disease Study, however the data do not distinguish among ACS and stable CAD [(3)].

ACS involves myocardial infarction (MI) and unstable angina. MI has conventionally been characterized by symptoms, electrocardiogram anomalies, and circulating biomarker levels, while unstable angina is classified for cases exhibiting clinical signs of MI without elevated biomarker levels [(4)]. The categorization of MI based on acute ECG alterations into STEMI and NSTEMI underpins modern treatment techniques [(5)].

Recent guidelines, such as the 2021 ACC/AHA/SCAI recommendations, advocate for individualized treatment approaches based on the patient's risk profile. High-risk NSTEMI patients may benefit from an early invasive strategy, which includes early CABG rather than conservative management or delayed procedures. This approach aligns with findings that indicate early intervention tends to result in better clinical outcomes for NSTEMI patients [(6, 7)].

This research aimed to assess the early outcome of CABG in cases with recent NSTEMI.

PATIENTS AND METHODS

This study is an analytical, observational, prospective, case-control study on 80 patients who were admitted for CABG surgery at Kasr Al Ainy Hospitals through the period from September 2024 to February 2025.

Participants have been separated into two groups: Group (1) included 40 cases with recent non-STEMI within 2 weeks of operation and group (2) involved 40 patients without MI who underwent CABG.

Inclusion criteria: Adult patients indicated for isolated CABG with recent non-STEMI (within 2 weeks) and adult patients indicated for isolated CABG without any history of MI.

Exclusion criteria: Patients with a history of cardiac surgery, combined CABG with other valve surgery, any patient with an old MI (More than 2 weeks), a patient with a recent STEMI within 2 weeks, minimally invasive CABG, and patients with other comorbidities (e.g., hepatic, renal, neurological, hematological, morbid obesity BMI > 24).

METHODS

All patients have been subjected to the following:

Preoperative data: Demographics: Gender, age, body mass index (BMI), HbA1c, diabetes mellitus (Identified by fasting blood glucose >125 mg/dL on two occasions, symptoms with random glucose > 200 mg/dL (ADA), or history of antidiabetic medication), hypertension (Diagnosed by DBP > ninety mmHg and/or SBP > 140 mmHg on two or more occasions, or history of antihypertensive use, LVEF, and history of MI: STEMI or NSTEMI).

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Intraoperative data: Type of CABG: On-pump vs. off-pump, number of grafts, cardiopulmonary bypass time, cross-clamp time, duration of surgery, and intraoperative events.

Surgical techniques: The CABG procedure was performed using either on-pump or off-pump techniques, with all patients receiving similar anesthetic medications. After placing the patient in the supine position, a full median sternotomy was carried out, and the left internal mammary artery (LIMA) was collected, either skeletonized or pedicled. Saphenous vein grafts have been utilized in most patients, with radial artery harvesting in some cases. Following pericardial opening, off-pump surgeries utilized a stabilizer, while on-pump procedures involved aortic and atrial cannulation for cardiopulmonary bypass. A cardioplegia cannula was placed in the ascending aorta for warm antegrade cardioplegia. Cardiopulmonary bypass commenced after graft preparation, followed by aortic cross-clamping. Protection of the myocardium has been attained under mild hypothermia utilizing intermittent warm blood cardioplegia. Distal anastomoses were guided by angiographic and visual assessment and constructed with continuous 7/0 or 8/0 polypropylene sutures. Following the completion of all distal anastomoses, the aortic cross-clamp has been eliminated, and proximal anastomoses have been conducted utilizing 6/0 polypropylene sutures after punching the aortic wall. Air was evacuated from grafts, and hemostasis was ensured. In on-pump cases, weaning from bypass was supported with inotropes or an intra-aortic balloon pump if needed. Chest tubes were inserted into the left pleural cavity and anterior mediastinum, leaving the pericardium open anteriorly in all patients while avoiding retrocardiac tubes. Finally, heparin was reversed using protamine sulfate at a 1:1 ratio.

Postoperative data: Early outcomes within 30 days post-surgery: Renal complications: Acute kidney injury and need for dialysis. Cardiac complications: Arrhythmias and heart failure. Surgical complications: Bleeding, need for reopening, cerebrovascular strokes (CVS), need for intra-aortic balloon, need for high-dose inotropes, length of ICU stay, total hospital stay, and mortality.

Postoperative care: Postoperative bleeding was assessed by chest drainage in the first 24 hours. All cases have been transferred to the ICU on mechanical ventilation with continuous monitoring and frequent blood gas analysis. ECGs were done on admission and every 12 hours. Signs of ischemia with elevated cardiac enzymes or thrombosed grafts required reoperation. Routine labs were performed, and patients were weaned from ventilation once stable and meeting respiratory criteria. Inotropes were tapered based on vital signs, perfusion, and lactate levels. Patients moved to the ward after achieving hemodynamic stability and chest drain removal and were discharged when fully stable, infection-free, with clean wounds and normal clinical exams.

Potential complications: While CABG is generally safe, it can have complications including infection, bleeding, arrhythmia, stroke, graft failure, and pulmonary complications.

Outcome measures: The primary outcome measures included hospital mortality, the necessity for intra-aortic balloon pump support, and the length of ICU and hospital stay. Secondary outcomes involved renal complications, such as acute renal injury described by a rise in serum creatinine or the need for dialysis and the requirement for high doses of inotropic support.

Ethical consideration: This study was carried out with permission from Kasr-Alainy Hospitals' Ethics Committee [Under code ms-336-2024]. Written informed permission was obtained from each participant. All patient information was kept private, and the study complied with the Declaration of Helsinki's guidelines.

Statistical analysis

SPSS version 26.0 was used to analyze the data. To confirm normalcy, the Shapiro-Wilk test was applied. Counts and percentages were used to describe qualitative features, while mean ± SD or median and interquartile range were used to report quantitative data if it was regularly distributed. The X^2-test or Fisher's exact test were used for qualitative data, while the independent samples T-test or ANOVA were used for quantitative data that is normally distributed, and the Mann-Whitney or Kruskall-Wallis tests for independent data that is not normally distributed. P-values ≤ 0.05 were regarded as statistically significant.

RESULTS

The mean age was 54.50 ± 6.89 years, ranging between 42 and 66 years in the NSTEMI group, while the mean age was 57.13 ± 7.24 years, ranging between 43 and 70 years in the group. Insignificant variance has been reported among studied groups regarding gender, age, or BMI (p above 0.05) (Table 1).

Table (1): Comparative analysis among examined groups regarding anthropometric and demographic data

			Group A (NSTEMI)	Group B	P value
Demographic and anthropometric data	**Age (years)**	**Mean ± SD**	54.50 ± 6.89	57.13 ± 7.24	0.101
		Range	42.00-66.00	43.00-70.00	
	Gender	**Male**	32 (80.0%)	29 (72.5%)	0.431
		Female	8 (20.0%)	11 (27.5%)	
	BMI (kg/m^2)	**Mean ± SD**	22.82 ± 1.15	23.25 ± 1.12	0.094
		Range	21.00-25.00	21.00-25.00	

P-values below 0.05 have been regarded as statistically significant. BMI: body mass index, SD: standard deviation

No significant difference was reported between studied groups regarding incidence of on-pump operation, CBP time, cross-clamp time, operative time, or number of grafts (p above 0.05) (Table 2).

Table (2): Comparative analysis among examined groups regarding operative data

		Group A (NSTEMI)	Group B	P value
Pump	**On**	27 (67.5%)	26 (65%)	0.813
	Off	13 (32.5%)	14 (35%)	
Cardiopulmonary bypass time (hours)	**Mean ± SD**	2.72 ± 1.15h	2.30 ± 0.96h	0.147
	Range	1.00-5.50h	1.00-4.00h	
Cross clamp time (minutes)	**Mean ± SD**	123.28 ± 61.88m	98.41 ± 56.39m	0.147
	Range	35-220.00m	100-260.00m	
Operative time (hours)	**Mean ± SD**	5.04 ± 0.93m	5.13 ± 1.49m	0.737
	Range	3.00-6.00h	3.50-12.00h	
Number of grafts	**Mean ± SD**	3.00 ± 0.64h	2.85 ± 0.74h	0.334
	Range	2.00-4.00	2.00-5.00	

There was insignificant variance in intraoperative arrhythmia, bleeding, or mortality incidences between groups (p > 0.05). All patients required intraoperative drainage. Intraoperative arrhythmia occurred in 20% of the NSTEMI group and 15% of group B, controlled with DC shock (Table 3).

Table (3): Comparative analysis among examined groups regarding operative events

	Group A (NSTEMI)		Group B		P value
	Count	%	Count	%	
Arrhythmia	8	20.0%	6	15.0%	0.556
Bleeding	0	0.0%	0	0.0%	1
Mortality	0	0.0%	0	0.0%	1

There was insignificant variance in postoperative data incidences among groups (p above 0.05), with no need for hemodialysis, inotropes, or reoperation, and 95% of patients did not require inotropes, and 5% needed high-dose inotropes (Table 4).

Table (4): Comparative analysis among examined groups regarding postoperative events

Postoperative	Group A (NSTEMI)		Group B		P value
	Count	%	Count	%	
Arrhythmia	5	12.5%	6	15.0%	1
Stroke	0	0.0%	0.0%	0%	1
Hemodialysis	0	0.0%	0	0.0%	1
Intra-aortic balloon	0	0%	0	0%	1
High dose Inotropes	2	5.0%	2	5.0%	1
Reoperation	3	7.5%	0	0.0%	0.241

There was insignificant variance in hospital stay duration among the NSTEMI and B groups, with the NSTEMI group having a mean period of 5.98 days and the B group having a mean period of 6.52 days (p > 0.05) (Table 5).

Table (5): Comparative analysis among examined groups regarding ICU and hospital stay durations

	Group A (NSTEMI)		Group B		P value
	Mean±SD	Range	Mean±SD	Range	
Intensive care unit stay (days)	3.35±0.58	2.00-4.00	3.10±0.87	2.00-5.00	0.135
Hospital stay (days)	5.98±0.95	4.00-7.00	6.25±0.78	5.00-8.00	0.080

Insignificant variance has been reported among studied groups regarding incidence of mortality (p above 0.05). No mortality was reported among the studied groups (Table 6).

Table (6): Comparative analysis among examined groups regarding postoperative mortality

Postoperative	Group A (NSTEMI)		Group B		P value
	Count	%	Count	%	
Mortality	0	0.0%	0	0.0%	1

DISCUSSION

The mean age was 54.50 ± 6.89 years, ranging between 42 and 66 years in the NSTEMI group in the current study. Older age was reported in **Kaya *et al.*** [8] study that enrolled 79 patients with NSTEMI and unstable angina who had on-pump CABG with total revascularization. Preoperatively, the cases had a mean age of 60.9 years. Older age was also reported by **Grothusen *et al.*** [9] in a study that included 461 patients with NSTEMI with a mean age of 70 years, ranging between 62 and 75 years.

Mean BMI was 22.82 ± 1.15 kg/m² ranging between 21 and 25 kg/m² in the NSTEMI group. Higher BMI was previously reported; the patients had a mean BMI of 28.0 in **Kaya *et al.*** [8] study.

Mean duration from MI in the NSTEMI group was 8.05 ± 3.30 days, ranging between 4 and 14 days. Meanwhile, time to surgery was not significantly different between the studied groups regarding the incidence of on-pump operation. Incidences of on-pump operation were 67.5% and 65.0% in the NSTEMI group and group B, respectively. Meanwhile, in both groups in **Fukui *et al.*** [10] study (ACS and stable angina groups), off-pump techniques in approximately ninety-seven percent of the cases.

No significant difference was reported between studied groups regarding incidences of postoperative arrhythmia. Similarly, **Fukui *et al.*** [10] observed insignificant variance among ACS and stable angina pectoris groups regarding frequency of postoperative arrhythmia.

Mean CBP time was 2.72 ± 1.15 hours in NSTEMI, which equals 163.2 ± 69 minutes. Shorter CBP time was reported by **Kaya *et al.*** [8]; intraoperatively, the mean CPB time was 84.0 minutes.

Mean cross-clamp time in the NSTEMI group in our study was 123.28 ± 61.88 minutes. Shorter cross-clamp time was reported by **Kaya *et al.*** [8]; intraoperatively, the mean aortic cross-clamp time was 49.0 min.

No significant difference was reported between studied groups regarding operative time. In agreement with our study, **Fukui *et al.*** [10] demonstrated that no significant difference was reported between ACS and stable angina pectoris patients regarding operative time in the study.

Mean operative time was 302.4 ± 55.8 minutes in the NSTEMI group. Shorter operative time (264.7 ± 62.3 minutes) was reported in ACS patients in **Fukui *et al.*** [10] study. The shorter operative time can be attributed to the large number of cases that had CABG through off-pump technique.

Postoperative arrhythmia was reported in 20% of cases in the NSTEMI group and 15% of cases in group B. The incidence of postoperative arrhythmia in **Fukui *et al.*** [10] study was lower than in our study: 0.8% of patients in the ACS group. This effect can be attributed to off-pump techniques in approximately ninety-seven percent of cases.

The research found no significant difference in the postoperative need for inotropes among the studied groups. Inversely, **Fukui *et al.*** [10] reported that the ACS group had a higher prevalence of low output syndrome (3.1% vs. 1.2%).

No significant difference was reported between the groups studied regarding postoperative need for hemodialysis. In disagreement, the ACS group had a greater incidence of hemodialysis requirement (2.9% vs 1.1%) in **Fukui *et al.*** [10] study, which can be explained by the large number of cases that needed high inotropic support due to low cardiac output syndrome.

In the present study, 7.5% of patients in the NSTEMI group needed reoperation for bleeding. Similarly, **Malmberg *et al.*** [11] reported 5.5% re-sternotomy in NSTEMI patients after CABG.

No significant difference was reported between studied groups in our research regarding hospital stay or ICU stay duration. In discrepancy with our study, **Saxena *et al.*** [12] study compared hospital resource utilization among patients with NSTEMI, STEMI, and unstable angina (UA). They found that NSTEMI cases had a mean hospital length of stay of 3.7 days, which was shorter than that of non-ACS cases (4.75 days) and UA cases (2.99 days). Regarding ICU care, 14.4% of NSTEMI cases received it, compared to 79.1% of STEMI cases and 9.3% of UA cases. STEMI cases were 11.7 hours, ranging between 6.4 and 22.0 hours.

In **Grothusen *et al.*** [9] study, the mortality coefficient was -0.517 (p = 0.019; odds ratio = 0.596; 95% CI: 0.388–0.917), concluding that the duration between MI and CABG has a direct effect on results after CABG. Whereas the longer the period among CABG and MI, the lower the mortality risk, it is, however, difficult to decide on an exact cut-off time frame.

No mortality was reported after CABG in the NSTEMI group. Inversely, **Kaya *et al.*** [8] reported that early-term outcomes revealed a 2.5% rate of mortality. Moreover, **Grothusen *et al.*** [9] reported that thirty-day mortality was 6.6% in non-STEMI cases.

Current research has revealed that short-term mortality rates after CABG in cases with NSTEMI remain a critical concern. These studies have taken into account various factors influencing outcomes, including patient demographics, timing of surgery, and clinical

profiles. One significant finding from a meta-analysis and systematic review by **Comanici *et al.* [13]** is that women undergoing CABG tend to exhibit a higher risk of short-term mortality compared to their male counterparts. This gender disparity highlights the need for targeted health strategies for women post-surgery, especially following NSTEMI events.

No significant difference was reported between studied groups in our study regarding mortality. In discrepancy with our study, **Malmberg *et al.* [11]** reported that in-hospital mortality (8.6% vs. 1.6%; P below 0.0001) was more frequent in MI cases than stable CAD cases. **Malmberg *et al.* [11]** explained that the rise in mortality of MI cases is correlated with a greater possibility of both procedural (e.g., early bypass dysfunction) and MI-related complications.

CONCLUSION

Based on our study, CABG in patients with recent NSTEMI had comparable outcomes with patients without MI, including hospital mortality, intra-aortic balloon use, length of ICU stay and hospital stay, need of hemodialysis, and high dose of inotropes. There was insignificant variance involving the two groups.

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