Outcomes of urgent coronary artery bypass graft surgery following non-ST elevation myocardial infarction

Abstract

Background: Non-ST elevation myocardial infarction (NSTEMI) significantly reduces patient survival, a condition that is essential for the optimization of results and the restoration of effective vascular flow multivessel coronary artery disease, Emergency coronary artery bypass grafting (CABG) is frequently contemplated. In the aftermath of NSTEMI, the objective of this investigation is to assess the results of urgent CABG, to prioritize risk stratification through the use of the Global Registry of Acute Coronary Events (GRACE) score

Methods: An analysis of 60 consecutive patients who underwent emergent CABG following NSTEMI was conducted retrospectively. Data on patients were obtained from a prospectively compiled database, and the GRACE score was implemented to evaluate the probability of mortality. Patients were divided into three risk categories: low (<10%), intermediate (10-19%), and high (≥20%), based on their predicted mortality percentages.

Results: Patients in the high-risk group (Group 3) exhibited significantly lower Euro Scores and ejection fractions (EF) than those in the low and intermediate groups, as demonstrated by the study. Additionally, the cross-clamp time was notably longer in Group 3, highlighting the urgency of intervention in this population The postoperative complications' overall incidence did not differ significantly between the groups. Even though Group 3 exhibited an increased in-hospital mortality rate.

Conclusions: The findings underscore the importance of timely intervention and tailored management strategies for NSTEMI patients, more specifically, the individuals who have been classified as high-risk by the GRACE score. This study contributes to the growing body of literature supporting urgent CABG as a lifesaving procedure and emphasizes the need for further research to optimize outcomes in this vulnerable patient population. The results advocate for a multidisciplinary approach to enhance perioperative care and improve survival rates among NSTEMI patients undergoing CABG.

Keywords: Non-ST elevation myocardial infarction (NSTEMI), Coronary artery bypass grafting (CABG), Global Registry of Acute Coronary Events (GRACE) score, Multivessel coronary artery disease, Postoperative complications, Urgent intervention, Patient outcomes

1. Introduction

Myocardial infarction (MI) is one of the primary causes of mortality worldwide and is one of the acute symptoms of coronary artery disease (CAD). As "time is muscle," persistent ischemia remains a significant risk factor for this condition, leading to loss of contractility and/or cardiac cell death with potentially fatal arrhythmias. Therefore, restoring coronary blood flow as quickly as possible is the obvious primary therapeutic objective in MI. [1]

MI is typically classified into two principal categories: ST-elevation MI (STEMI) and non-ST-elevation MI (NSTEMI). Acute coronary syndrome (ACS) status is also conferred upon unstable angina, as it serves as the immediate background for MI .[2]

Coronary artery bypass grafting (CABG) is a safe and viable alternative for patients with acute coronary syndrome (ACS). Additionally, it is an appropriate treatment for severe multivessel disease, diabetes mellitus, and PCI failure. CABG can facilitate the rapid completion of revascularization and mitigate heart ischemia. [3]

However, In the past, patient management has been less aggressive in terms of the time point of revascularization in NSTEMI, in contrast to STEMI, ischemia is considered less critical. In addition, the argument has been advanced that the likelihood of complications during surgery is reduced in cases of NSTEMI by deferring coronary artery bypass grafting (CABG) .[1]

Conversely, patients with multivessel coronary artery disease who exhibited NSTEMI exhibited enhanced survival, as well as a decrease in the incidence of significant adverse cardiac and cerebrovascular events and readmission following revascularization with CABG, as demonstrated by specific studies. The decision to perform urgent CABG in NSTEMI patients is considered controversial. [4,5]

The Global Registry of Acute Coronary Events (GRACE) score is one of the most frequently used scores in the daily clinical practice of identifying in-hospital hazards and long-term mortality for ACS patients [6]. In an effort to anticipate risk, the GRACE risk score model employs eight variables: age, systolic blood pressure, heart rate, Scr, cardiac arrest at admission, elevated cardiac biomarkers, ST-segment deviation, and Killip class. [7]

In addition, the clinical endpoint of all-cause mortality in risk assessment models exhibits exceptional discriminatory capabilities [8]. According to the most recent recommendations, Within

24 hours, patients who have experienced a non-STEMI and have a GRACE risk score of 140 or higher should implement an early invasive strategy [9].

The purpose of this study is to assess the outcomes of emergent CABG following NSTEMI using the Global Registry of Acute Coronary Events (GRACE) score, with a particular focus on risk stratification.

2. Method

2.1.Study design and target group:

The GRACE score was used to assess the mortality risk of 60 consecutive patients who underwent emergent CABG following a non-ST elevation myocardial infarction (NSTEMI). Patients were identified from a database containing prospectively collected data. Case notes were then retrospectively reviewed to confirm NSTEMI diagnoses in accordance with the European Society of Cardiology (ESC) guidelines.

2.2. GRACE Score Calculation:

The standardized GRACE risk models, which are available online, were employed to determine the GRACE score and the anticipated mortality rate during hospitalization and at six months. '(https://www.mdcalc.com/calc/1099/grace-acs-risk-mortality-calculator) [10].'

2.3. Risk Group Classification:

This structured approach to risk stratification using the GRACE score is crucial for identifying patients at higher risk of mortality following NSTEMI, to enable the implementation of customized management strategies that enhance results. The GRACE prediction of the percentage risk of mortality at six months was used to categorize patients into three risk groups:

Risk Group 1: Low (<10% mortality)

The second group is classified as: intermediate risk. (10–19% mortality)

Group three: High-risk (≥20% mortality)

2.4. Study methods:

Every patient included in this research underwent CABG concurrently with their ACS hospitalization. Within thirty days of the index hospital admission, but after 24 hours, all surgeries were carried out. All patients kept taking aspirin until the day before surgery, in spite of the fact that clopidogrel was discontinued at least five days in advance. Before the operation, At the operation team's discretion, Intra-aortic balloon pumps were administered to patients who experienced persistent angina symptoms or had extensive left main stem disease. All interventions

were performed using cardiopulmonary bypasse to protect the heart, There was authorization for the operating surgeon to administer intermittent antegrade warm or cold blood cardioplegia. Anesthetic and postoperative care were conducted in accordance with departmental protocols.

2.6. Data Management

Version 27 of SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) was employed to conduct the statistical analyses. The numerical data were displayed in terms of their mean and standard deviation (SD). However, in both percentages and numerical formats, categorical data was presented. The chi-square test is employed. The differences between the categories were determined, when appropriate, Fisher exact, and on-the-fly ANOVA experiments. 0.05 was the acceptable level of significance.

Results

Table 1 illustrates that group 3 had the lowest EF compared with the other two groups (p=0.026). Also, EuroSCORE was significantly low among group 3 (p=0.034).

Table 2 It is confirmed that the cross-clamp time of group 3 was 56.7±9.6, This was significantly longer than the other two categories (p=0.032).

Table 3 exhibits that non-significant difference between the 3 groups regarding post-operative complications

3. Discussion

The current study's findings give light on the implications of emergency coronary artery bypass grafting (CABG) in connection to non-ST elevation myocardial infarction (NSTEMI). The findings underscore the complexities of managing NSTEMI patients, particularly in the context of timely revascularization and risk stratification using the GRACE score.

Our study reinforces the notion that urgent CABG can be a lifesaving intervention for NSTEMI patients, particularly those with multivessel disease. Previous literature, including studies by Ram et al. (2020), In Non-STEMI patients, The frequency of significant adverse cardiac events is diminished, and survival rates are improved by timely surgical revascularization, according to a study[11]. Rojas et al. observed that the mortality rates of early CABG outcomes were comparable to those of delayed revascularization.[1]

The urgency of intervention is particularly critical given that NSTEMI often correlates with significant coronary artery disease, which, if left untreated, can culminate in severe ischemic complications.

The relevance of the GRACE score in clinical decision-making is underscored by its use to stratify risk in our patient population. For patients suffering from acute coronary syndromes (ACS), the GRACE score reliably foretells both their in-hospital mortality and their long-term consequences .[12]

In accordance with the most current recommendations, which advocate for early invasive procedures for high-risk NSTEMI patients, we were able to create individualized treatment plans by dividing patients into low-, intermediate-, and high-risk categories .[9]

The results indicated that patients in Group 3 (high risk) had significantly lower ejection fractions (EF) and Euro Scores compared to Groups 1 and 2. This outcome is consistent with previous research that has demonstrated a correlation between adverse post-CABG outcomes and decreased EF [1314].

In the same vein, Senanayake et al., discovered that the EuroSCORE estimated a higher preoperative risk profile for the higher GRACE score risk groups. [15]

The EuroSCORE, which assesses the surgical risk, remains an essential tool in predicting postoperative complications, and its correlation with worse outcomes in high-risk patients underscores the necessity for careful preoperative evaluation and planning.

The significant difference in cross-clamp time among the groups, especially the prolonged duration in Group 3, is noteworthy. Extended cross-clamp times can lead to myocardial ischemia and subsequent complications, which aligns with findings from Ruggieri et al. (2018) indicating that prolonged ischemia adversely affects postoperative recovery. The results of the multivariate analysis showed that the duration of the cross-clamp was a significant determinant of mortality within 30 days ($p<0.0001$, OR 1.027, 95%CI 1.015-1.039) [16] . Additionally, Shultz et al. reported that prolonged cross clamp durations were linked to adverse clinical outcomes [17]. These data suggest that while urgent CABG is critical for high-risk patients, operative strategies must prioritize minimizing ischemic time to enhance recovery and outcomes.

Our study's results indicated a higher in-hospital mortality rate in Group 3, although the aggregate incidence of complications did not differ significantly between the categories. In accordance with a study, the GRACE score had a C statistic that ranged from 0.842 to 0.923, indicating good

predictive precision for in-hospital mortality [18]. This supports your finding of higher mortality in patients with elevated GRACE scores. Although your investigation did not identify any substantial disparities in the incidence of complications among the various categories, other research has shown varying results. For instance, a study comparing different risk scores for STEMI patients noted that while the GRACE score effectively predicted mortality, it did not necessarily correlate with a higher incidence of complications, suggesting that mortality risk and complication rates may not always align [18].This could imply that patients with high GRACE scores may experience mortality due to factors not directly related to complications. The relatively low rates of postoperative complications across the risk groups suggest that with appropriate surgical and perioperative management, even high-risk patients can achieve acceptable outcomes. This reinforces the importance of multidisciplinary approaches in managing NSTEMI patients, involving cardiologists, surgeons, and critical care teams to optimize perioperative care.

Our research provides valuable insights; Nevertheless, its limitations must be recognized. The results may not be applicable to a broader population due to the retrospective nature of the study. as well as a small sample size. is able to introduce bias into the selecting process. In addition, the single-center design may not adequately account for the diverse practices that are present in a variety of healthcare environments.

4. Conclusion

In conclusion, our study highlights the critical role of urgent CABG in managing NSTEMI patients, particularly those identified as high-risk via the GRACE score. The findings emphasize the need for timely intervention, tailored management strategies, and ongoing research to optimize outcomes in this vulnerable patient population. As the landscape of cardiac surgery continues to evolve, our insights contribute to the ongoing dialogue surrounding the best practices for treating NSTEMI and improving patient care.

5. References

1. Rojas S V., Trinh-Adams ML, Uribarri A, et al. Early surgical myocardial revascularization in non-ST-segment elevation acute coronary syndrome. *J Thorac Dis*. 2019;11(11):4444-4452. doi:10.21037/jtd.2019.11.08
2. Salari N, Morddarvanjoghi F, Abdolmaleki A, et al. The global prevalence of myocardial infarction: a systematic review and meta-analysis. *BMC Cardiovasc Disord*.

2023;23(1):206. doi:10.1186/s12872-023-03231-w

3. Lang Q, Qin C, Meng W. Appropriate Timing of Coronary Artery Bypass Graft Surgery for Acute Myocardial Infarction Patients: A Meta-Analysis. *Front Cardiovasc Med*. 2022;9. doi:10.3389/fcvm.2022.794925
4. Huckaby L V., Sultan I, Mulukutla S, et al. Revascularization following non-ST elevation myocardial infarction in multivessel coronary disease. *J Card Surg*. 2020;35(6):1195-1201. doi:10.1111/jocs.14539
5. Davierwala PM, Verevkin A, Leontyev S, Misfeld M, Borger MA, Mohr FW. Does Timing of Coronary Artery Bypass Surgery Affect Early and Long-Term Outcomes in Patients With Non–ST-Segment–Elevation Myocardial Infarction? *Circulation*. 2015;132(8):731-740. doi:10.1161/CIRCULATIONAHA.115.015279
6. van der Sangen NMR, Azzahhafi J, Chan Pin Yin DRPP, et al. External validation of the GRACE risk score and the risk–treatment paradox in patients with acute coronary syndrome. *Open Hear*. 2022;9(1):e001984. doi:10.1136/openhrt-2022-001984
7. Chen X, Wu H, Li L, Zhao X, Zhang C, Wang WE. The prognostic utility of GRACE risk score in predictive adverse cardiovascular outcomes in patients with NSTEMI and multivessel disease. *BMC Cardiovasc Disord*. 2022;22(1):568. doi:10.1186/s12872-022-03025-6
8. Fox KAA, FitzGerald G, Puymirat E, et al. Should patients with acute coronary disease be stratified for management according to their risk? Derivation, external validation and outcomes using the updated GRACE risk score. *BMJ Open*. 2014;4(2):e004425. doi:10.1136/bmjopen-2013-004425
9. Collet JP, Thiele H, Barbato E, et al. 2020 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. *Eur Heart J*. 2021;42(14):1289-1367. doi:10.1093/eurheartj/ehaa575
10. MEDCALC. GRACE ACS Risk and Mortality Calculator. Accessed January 10, 2024. https://www.mdcalc.com/calc/1099/grace-acs-risk-mortality-calculator
11. Ram E, Sternik L, Klempfner R, et al. Outcomes of different revascularization strategies among patients presenting with acute coronary syndromes without ST elevation. *J Thorac Cardiovasc Surg*. 2020;160(4):926-935.e6. doi:10.1016/j.jtcvs.2019.08.130
12. Tran AV, Truong DD, Ngo TH, Nguyen OTK, Tran SK, Huynh PK. Prognostic value of in-

hospital and 6-month mortality after acute coronary syndrome using GRACE, TIMI, and HEART scores. *Med Clínica Práctica*. 2024;7(2):100419. doi:10.1016/j.mcpsp.2023.100419

13. Najafi MS, Nematollahi S, Vakili-Basir A, et al. Predicting outcomes in patients with low ejection fraction undergoing coronary artery bypass graft. *IJC Hear Vasc*. 2024;52:101412. doi:10.1016/j.ijcha.2024.101412
14. Karedath J, Nazly S, Murtaza SF, et al. Comparison of Early and Long-Term Mortality in Patients With Reduced and Preserved Ejection Fraction Undergoing Coronary Artery Bypass Graft: A Systematic Review and Meta-Analysis. *Cureus*. Published online 9 August 2023. doi:10.7759/cureus.43245
15. Senanayake EL, Howell NJ, Evans J, et al. Contemporary outcomes of urgent coronary artery bypass graft surgery following non-ST elevation myocardial infarction: urgent coronary artery bypass graft surgery consistently outperforms Global Registry of Acute Coronary Events predicted survival. *Eur J Cardio-Thoracic Surg*. 2012;41(5):e87-e92. doi:10.1093/ejcts/ezr303
16. Ruggieri VG, Bounader K, Verhoye JP, et al. Prognostic Impact of Prolonged Cross-Clamp Time in Coronary Artery Bypass Grafting. *Hear Lung Circ*. 2018;27(12):1476-1482. doi:10.1016/j.hlc.2017.09.006
17. Shultz B, Timek T, Davis AT, et al. Outcomes in patients undergoing complex cardiac repairs with cross clamp times over 300 minutes. *J Cardiothorac Surg*. 2016;11(1):105. doi:10.1186/s13019-016-0501-4
18. Wang CH, Wang HT, Wu KH, et al. Comparison of Different Risk Scores for Prediction of In-Hospital Mortality in STEMI Patients Treated with PPCI. Xu G, ed. *Emerg Med Int*. 2022;2022:1-7. doi:10.1155/2022/5389072

Table 1: Pre-operative demographics

Parameters		Group 1 (no=43)	Group 2 (no=10)	Group 3 (no=7)	p-value
Age, Mean ± SD		66.3±7.8	60.3±7.2	64.6±11.5	0.121
Gender	Male	25 (58.1)	5 (50.0)	4 (57.1)	0.916
	Female	18 (41.9)	5 (50.0)	3 (42.9)	
CCS, no (%)	Class I	14 (32.6)	6 (60.0)	2 (28.6)	0.256
	Class II	10 (23.3)	0 (0.0)	3 (42.9)	
	Class III	13 (30.2)	4 (40.0)	1 (14.3)	
	Class IV	6 (14.0)	0 (0.0)	1 (14.3)	
NYHA, no (%)	Class I	12 (27.9)	1 (10.0)	4 (57.1)	0.225
	Class II	11 (25.6)	3 (30.0)	3 (42.9)	
	Class III	13 (30.2)	3 (30.0)	0 (0.0)	
	Class IV	7 (16.3)	3 (30.0)	0 (0.0)	
Previous MI, no (%)		14 (32.6)	4 (40.0)	4 (57.1)	0.488
DM, no (%)		21 (48.8)	3 (30.0)	4 (57.1)	0.509
COPD/Asthma, no (%)		12 (27.9)	2 (20.0)	0 (0.0)	0.235
Triple vessels disease, no (%)		10 (23.3)	4 (40.0)	2 (28.6)	0.643
LMS disease, no (%)		21 (48.8)	6 (60.0)	5 (71.4)	0.554
Ejection fraction, Mean ± SD		47.4±11.2	45.7±12.7	34.1±12.6	**0.026***
EuroSCORE, Mean ± SD		9.0±3.8	8.0±3.8	6.3±3.0	**0.034***

**Indicates significant p-value at 0.05*

Table 2: Operative characteristics

Parameters	Group 1 (no=43)	Group 2 (no=10)	Group 3 (no=7)	p-value
CPB time, Mean ± SD	103.72±14.8	104.2±15.3	112.6±20.1	0.377
Cross-clamp time, Mean ± SD	41.9±13.5	44.2±15.4	56.7±9.6	**0.032***
No. distal grafts ≥3, no (%)	20 (46.5)	6 (60.0)	6 (85.7)	0.129

**Indicates significant p-value at 0.05*

Table 3: Post-operative complications by GRACE risk group

Parameters	Group 1 (no=43)	Group 2 (no=10)	Group 3 (no=7)	p-value
In-hospital mortality, no (%)	3 (7.0)	0 (0.0)	2 (28.6)	0.093
Episode of LCOS, no (%)	22 (51.2)	7 (70.0)	4 (57.1)	0.550
Arrhythmias, no (%)	19 (44.2)	5 (50.0)	3 (42.9)	1.0
Re-operation	18 (41.9)	4 (40.0)	6 (85.7)	0.106
Hours ventilated, Mean ± SD	16.2±6.2	17.5±6.0	21.4±5.3	0.112
Respiratory complications	5 (11.6)	1 (10.0)	1 (14.3)	1.0
Post-operative Stroke, no (%)	1 (2.3)	1 (10.0)	1 (14.3)	0.191
Cr >200 µmol/l, no (%)	13 (30.2)	6 (60.0)	2 (28.6)	0.231
CVVH, no (%)	2 (4.7)	1 (10.0)	1 (14.3)	0.747

LCOS: low cardiac output syndrome, Cr=creatinine; CVVH: continuous veno-venous hemofiltration.