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# Percutaneous Coronary Intervention in Patients with Left Main Coronary Artery Disease and Cardiogenic Shock

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## ABSTRACT

**Introduction:** Cardiogenic shock of patients with myocardial infarction still affects between 3-10% of patients, and the in-hospital death rate is <30%. One of the challenges is the left main (LM) coronary intervention.

**Objective:** The aim of the current study is to investigate the short-term outcome of emergency LM coronary intervention.

**Patients and methods:** A total of 80 patients who underwent percutaneous coronary intervention (PCI) of LM in the setting of cardiogenic shock in our hospital were retrospectively studied. Short-term clinical outcomes and PCI characteristics were evaluated.

**Results:** LM was the culprit artery in ]about 62.8% of the patients. The remaining cases were treated due to persistence of cardiogenic shock after successful PCI of the culprit vessel. About 43.6% of the patients had Syntax scores more than 32, and the majority of them had complicated coronary stenosis. Second stent method at the LM bifurcation was employed in 12.8% of cases, complete revascularization in 34.6%, and intra-aortic balloon pump (IABP) in 13.1%. Mortality in hospitals was 48.7%. Half of the patients had no differences between 1 or 2 stent LM bifurcation procedures at 90 days' follow-up. Patients with incomplete revascularization with a residual Syntax score of 15 or more and those with thrombolysis in myocardial infarction (TIMI) flow.

**Conclusion:** Neither the use of IABP nor the 2-stent approach in the LM showed a decreased short-term mortality in patients who first presented with cardiogenic shock and LM illness. However, in our study, patients with ultimate TIMI flow <III showed greater short-term mortality.

**Keywords:** Cardiogenic shock, Myocardial infarction, Coronary artery, Descriptive study, National Heart Institute.

## INTRODUCTION

Acute myocardial infarction may lead to one of the major complication which is cardiogenic shock, which may lead to death with a rate of about 60% [(1)].

In patients with acute coronary syndrome (ACS) accompanied by cardiogenic shock, the presence of left main (LM) disease is an important consideration when determining the revascularization method.

A small number of patients with percutaneous coronary intervention (PCI) of the LM were included in large trials of cardiogenic shock like Culprit shock or intra-aortic balloon pump (IABP) Shock II [(2)].

As a result, there is currently a shortage of information about the most effective treatment plans and clinical results for individuals with LM illness in the setting of cardiogenic shock. The PCI approach and short-term clinical outcomes of patients who had LM PCI in the setting of ACS complicated by cardiogenic shock are analyzed in the current study.

## PATIENTS AND METHODS

We performed a retrospective analysis of patients who underwent LM stenting at the National Heart Institute of Egypt, between April 2018 and April 2022 for the treatment of ACS exacerbated with cardiogenic shock.

ACS and coronary syndrome (CS) patients who underwent LM PCI due to persistent cardiogenic shock following treatment of the offending vascular were also included, regardless of whether the LM was the culprit artery. The culprit artery was found using the electrocardiogram (ECG) and the results of the angiography in cases of ST-elevation myocardial infarction (STEMI). The culprit artery in the case of non-ST-elevation myocardial infarction (NSTEMI) was determined to be LM illness based on clinical criteria and ECG changes employed by the treating physicians. As the index clinical manifestation, myocardial infarction (MI) following cardiac surgery is referred to as perioperative MI.

Patients with protected LM or death prior to stenting were excluded from the study.

The percutaneous treatment of all major arteries with significant stenosis determined by angiography by visual examination (70%) at any time during the hospital stay was referred to as complete revascularization. According to ESC 2015's recommendations, ACS is defined [(3)]. Patients with symptoms of poor peripheral perfusion and systolic blood pressure less than 90 mmHg are said to be in cardiogenic shock and may need inotropic or vasoactive medication assistance.

### Ethical Consideration:

**This study was ethically approved by the Institutional Review Board of the National Heart Institute. The participants were given an explanation of all the study's processes, along with any potential difficulties, while being emphasized the value of the data they would provide.**



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**Participants' data and study findings were kept completely private and confidential; nobody who wasn't a direct participant in the study was given access to them. Results of any abnormal tests or procedures were discussed with the patients. Patients had the choice to opt out, and doing so had no impact on the standard of care they could expect. Written informed consent was obtained from all participants.**

**This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.**

***Statistical Analysis***

The collected data were introduced and statistically analyzed by utilizing the Statistical Package for Social Sciences (SPSS) version 23.0 for windows (IBM Corp, Armonk, NY). Qualitative data were defined as numbers and percentages. Chi-Square test and Fisher's exact test were used for comparison between categorical variables as appropriate. Quantitative data were tested for normality by Kolmogorov-Smirnov test. Normal distribution of variables was described as mean and standard deviation (SD). The clinical, angiographic, and procedural features of patients who passed away in hospitals and those who survived were compared using a univariate analysis.

To investigate the determinants of in-hospital mortality, a multivariate analysis using a binary logistic regression was conducted to get the odds ratios (OR) and associated 95% confidence intervals (CI). For the multivariate model, factors linked to PCI with P <0.05 on univariate analysis were chosen. P value ≤0.05 was considered to be statistically significant.

**RESULTS**

A total of 80 patients participated in our study, with 39 (48.7%) patients died in the hospital. The mean age of all participants was 68 (SD 13) years (**Table 1**).

**Table (1):** Sociodemographic and clinical characteristics of the studied patients.

| Variable | Total (n= 80) | In Hospital Death | | P-value |
|---|---|---|---|---|
| | | Yes (n= 39) | No (n= 41) | |
| Male | 67 (83.8%) | 31 (46.3%) | 36 (53.7%) | 0.480 |
| Female | 14 (17.5%) | 8 (57.1%) | 5 (35.7%) | |
| Age ≥70 years old | 43 (53.8%) | 25 (58.1%) | 18 (41.9%) | 0.135 |
| Diabetes mellitus | 30 (37.5%) | 14 (46.7%) | 16 (53.3%) | 0.612 |
| Arterial hypertension | 54 (67.5%) | 25 (46.3%) | 29 (53.7%) | 0.444 |
| Chronic kidney disease | 13 (16.3%) | 4 (30.8%) | 9 (69.2%) | 0.055 |
| Smoker | 51 (63.8%) | 26 (51.0%) | 25 (49.0%) | 0.841 |
| Previous AMI | 18 (22.5%) | 8 (44.4%) | 10 (55.6%) | 0.508 |
| Previous PCI | 18 (22.5%) | 8 (44.4%) | 10 (55.6%) | 0.508 |
| **Clinical presentation *n* (%)** | | | | |
| STEMI | 46 (57.5%) | 23 (50.0%) | 23 (50.0%) | 1.000 |
| Fibrinolysis | 12 (15.0%) | 4 (33.3%) | 8 (66.7%) | 0.109 |
| Perioperative MI | 9 (11.3%) | 9 (100.0%) | 0 (0.0%) | <0.001** |
| NSTEMI | 29 (36.3%) | 17 (58.6%) | 12 (41.4%) | 0.194 |
| Cardiac arrest | 28 (35.0%) | 16 (57.1%) | 12 (42.9%) | 0.292 |

AMI: Acute myocardial infarction. MI: Myocardial infarction. Test to estimate P-value: Chi-square test

**Table 2** shows that the majority of patients exhibited complicated coronary architecture, with the involvement of multiple arteries than the LM (left anterior descending [80.8%] followed by left circumflex [52.6%], and right coronary artery [48.7%]) in 42.5% of cases with a Syntax score >32 points. In 82.1% of instances, the right coronary artery was predominating. The LM was the troublesome artery in 49 patients (62.8%), of whom 20.5% had initial TIMI flow of 0. Due to refractory shock and/or full revascularization, the LM was stented in the remaining patients who had another culprit artery.

**Table (2):** Comparison of diagnostic angiogram of the studied groups.

| Parameters | Total (n= 80) | In Hospital Mortality | | P-value |
|---|---|---|---|---|
| | | Yes (n= 39) | No (n= 41) | |
| **Syntax score** | | | | |
| ≤22 | 14 (17.5%) | 6 (42.9%) | 8 (57.1%) | 0.461 |
| 22–32 | 32 (40%) | 14 (43.8%) | 18 (56.3%) | 0.321 |
| >32 | 34 (42.5%) | 19 (55.9%) | 15 (44.1%) | 0.334 |
| **Culprit vessel** | | | | |
| LM | 50 (62.5%) | 28 (56.0%) | 22 (44%) | 0.086 |
| LAD | 19 (23.8%) | 8 (42.1%) | 11 (57.9%) | |
| LCX | 1 (1.3%) | 1 (100%) | 0 (0.0%) | |
| RCA | 6 (7.5%) | 0 (0.0%) | 6 (100%) | |
| Undetermined | 4 (5%) | 2 (50%) | 2 (50%) | |
| **TMI Flow** | | | | |
| 0 | 17 (21.3%) | 11 (64.7%) | 6 (35.3%) | 0.091 |
| 1 | 4 (5%) | 3 (75%) | 1 (25%) | 0.186 |
| 2 | 24 (30%) | 14 (58.3%) | 10 (41.7%) | 0.255 |
| 3 | 35 (43.8%) | 11 (31.4%) | 24 (68.6%) | 0.002* |
| **Bifurcation of LM** | 60 (75%) | 31 (51.7%) | 29 (48.3%) | 0.711 |
| **Medina 1.1.1** | 43 (53.8%) | 23 (53.5%) | 20 (46.5%) | 0.519 |
| **Other vessels** | | | | |
| LAD | 64 (80%) | 31 (48.4%) | 33 (51.6%) | 0.718 |
| LCX | 42 (52.5%) | 20 (47.6%) | 22 (52.4%) | 0.662 |
| RCA | 39 (48.8%) | 18 (46.2%) | 21 (53.8%) | 0.505 |
| Bypass | 11 (13.8%) | 4 (36.4%) | 7 (63.6%) | 0.213 |

Test to estimate P-value: Chi-square test. P-value >0.05 is insignificant; *P-value ≤0.05 is significant.

**Table 3** shows that in 68 (87.2%) patients, a straightforward single stent technique was used in the majority of the situations. Between a single-stent technique and a two-stent strategy, there were no changes in the rate of in-hospital mortality (P= 0.445). There were no discernible differences in mortality between patients undergoing full revascularization and those receiving partial revascularization. A complete revascularization was conducted in admission for 34.6% of all patients.

**Table (3): Uni**variate analysis of LM PCI factors and in-hospital mortality.

| Variable | Total (n=80) | In Hospital Death | | Univariate Analysis | |
|---|---|---|---|---|---|
| | | Yes (n=39) | No (n=41) | OR (IC) | P-value |
| **Bifurcation technique** | | | | | |
| −1 stent | 70 (87.5%) | 33 (47.1%) | 37 (52.9%) | 0.631 (0.161-2.450) | 0.494 |
| Side branch dilatation | 25 (31.3%) | 13 (52.0%) | 12 (48%) | 1.125 (0.419-2.995) | 0.780 |
| Kissing balloon | 18 (22.5%) | 7 (38.9%) | 11 (61.1%) | 0.599 (0.193-1.851) | 0.189 |
| −2 stents | 12 (15.0%) | 7 (58.3%) | 5 (41.7%) | --- | |
| T stenting | 4 (5.0%) | 2 (50.0%) | 2 (50%) | | |
| TAP | 2 (2.5%) | 2 (100.0%) | 0 (0.0%) | | |
| Mini crush) | 3 (3.8%) | 3 (100.0%) | 0 (0.0%) | | |
| Culote | 6 (7.5%) | 3 (50.0%) | 3 (50%) | | |
| Final result | | | | | |
| Complete revascularization | 29 (36.3%) | 13 (44.8%) | 16 (55.2%) | 0.813 (0.321-2.097) | 0.432 |
| RSS ≥15 | 20 (25%) | 14 (70%) | 6 (30%) | 1.497 (0.977-2.297) | 0.013* |
| RSS ≥15 | 19 (23.8%) | 17 (89.5%) | 2 (10.5%) | 14.777 (3.103-46.074) | <0.001** |
| RSS ≥15 + final TIMI <3 | 10 (12.5%) | 9 (90%) | 1 (10%) | 11.128 (1.316-61.390) | <0.001** |
| IABP | 59 (73.8%) | 28 (47.5%) | 31 (52.5%) | 0.753 (0.279-2.065) | 0.589 |
| pre PCI IABP | 42 (52.5%) | 19 (45.2%) | 23 (54.8%) | 0.867 (0.353-2.129) | 0.382 |
| post PCI IABP | 18 (22.5%) | 9 (50%) | 9 (50%) | 1.134 (0.375-3.424) | 1.000 |

P-value estimated of Binary logistic regression

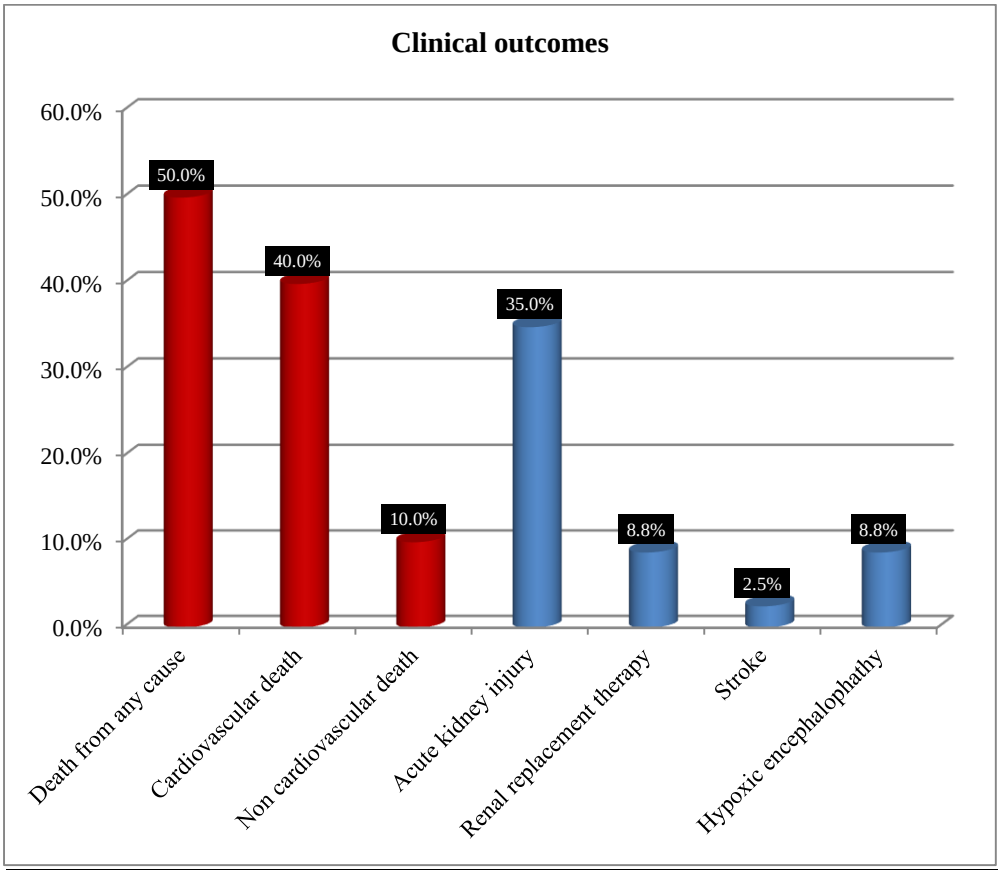
**Table 4** shows that patients with incomplete revascularization and a residual Syntax score of 15 or more, had a greater death risk according to univariate analysis (OR 1.61, CI: 1.05-2.47, P-value 0.048), but multivariate analysis failed to reach statistical significance (OR 1.94, P-value 0.34).

On both a univariate and multivariate analysis, patients with TIMI flow 3 in the left coronary artery at the conclusion of PCI had a higher in-hospital mortality rate (OR 15.52, P-value 0.013). At 90 days, death was numerically greater in patients whose LM was the culprit artery compared to those whose ACS was caused by other arteries (59.2 vs. 34.5%), but statistical significance was not reached (P-value 0.63 by log-rank test).

**Table (4):** Multivariate analysis of LM PCI factors and in-hospital mortality.

| Variables | OR | 95% IC | P-value |
|---|---|---|---|
| RSS ≥15 | 2.076 | 0.524-8.175 | 0.367 |
| Final TIMI <3 | 14.434 | 1.665-83.178 | 0.012* |
| RSS ≥15 + final TIMI <3 | 0.546 | 0.214-9.240 | 0.482 |

Test to estimate P-value: Binary logistic regression. P-value >0.05 is insignificant; *P-value ≤0.05 is significant.




| Clinical outcomes | No. | % |
|---|---|---|
| Death from any cause | 40 | 50% |
| Cardiovascular death | 32 | 40% |
| Non cardiovascular death | 8 | 10% |
| Acute kidney injury | 28 | 35% |
| Renal replacement therapy | 7 | 8.8% |
| Stroke | 2 | 2.5% |
| Hypoxic encephalophathy | 7 | 8.8% |

**Figure (1):** Clinical outcomes after 90 days-follow up.

## DISCUSSION

In the current study we have found that, most of the patients who had LM PCI accompanied with cardiogenic shock had a complex coronary arteries lesions, also a resulted TIMI flow <III in the territory of the left coronary is a big indicator of short-term mortality, and finally the majority of mortality had high residual syntax score.

Numerous studies have examined cardiogenic shock in recent years. The analysis of 67 patients with unprotected LM STEMI who had first PCI, revealed a substantial fatality rate that was equivalent to **Yap *et al.* (2018)** study (478.8%) [(4)].

Although the full revascularization at admission was not definitely linked to a reduction in short-term mortality in our investigation, the univariate analysis did indicate a higher risk of in-hospital mortality in patients with a post-PCI residual syntactic score (RSS) above 15. This may imply that it might be advantageous to work for a more thorough revascularization in these individuals. The cut-off value utilized in this study has not been confirmed in another cohort, thus it is important to proceed with care when interpreting these results. To find the answer to this issue, a multicenter registry of the right size would also be required.

By excluding patients with cardiogenic shock and suggesting an RSS score of more than eight points as a prognostic value, the RSS sub-analysis that was created from the syntactic research established a major distinction [(5)]. In cases of cardiogenic shock, including the LM, when restoring flow to the causative artery may be more important than performing a comprehensive revascularization, there are no clinical data to support the RSS's suggestion for the best revascularization approach. Normally, in our multivariable research, a final TIMI flow after LM PCI served as a stand-alone predictor of in-hospital death. Reaching TIMI 3 post-PCI flow was significantly associated with a decreased hospitalization mortality in this condition, according to data by **Yap *et al.*** (2018), **Pöss *et al.*** (2003), and **Webb *et al.*** (2017) [(4,6,7)].

Most mortality rates were observed during hospitalization and persisted until 90 days of follow-up, according to our analysis, which indicated that it was unrelated to stent methods or the use of IABP.

Thus, in our opinion, the main therapeutic objective for patients with CS involving the LM should be to enhance treatment during the acute phase with the aim of attaining a satisfactory functional reperfusion, including final TIMI flow 3 in the left coronary artery and a residual syntax below 15.

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**Conflict of Interest:** No conflict of interest present.

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