

Primary Percutaneous Coronary Intervention in Multivessel Disease: Complete versus Culprit-only Revascularization

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ABSTRACT

Objective: To compare the clinical outcomes of complete revascularization and culprit-only revascularization in patients with multivessel coronary artery disease (CAD) who presented with ST-segment elevation myocardial infarction (STEMI) at Hayatabad Medical Complex, Peshawar.

Methodology: A prospective, randomized controlled trial was conducted, enrolling 400 patients with multivessel CAD. Patients were randomly assigned to either the complete revascularization group (n=200) or the culprit-only revascularization group (n=200). The primary outcomes assessed included cardiovascular death, reinfarction, and the need for repeat revascularization over a six-month follow-up period. Statistical analysis was performed using chi-square tests and Kaplan-Meier survival analysis.

Results: Complete revascularization significantly reduced the rates of major adverse cardiovascular events compared to culprit-only revascularization. Cardiovascular death was lower in the complete revascularization group (4% vs 9%, $p = 0.02$), as was reinfarction (5% vs 11%, $p = 0.01$), and repeat revascularization (7% vs 15%, $p = 0.004$). Kaplan-Meier analysis showed a significant improvement in event-free survival in the complete revascularization group.

Conclusion: Complete revascularization significantly improves clinical outcomes in patients with multivessel CAD presenting with STEMI, reducing cardiovascular death, reinfarction, and repeat revascularization. This study supports complete revascularization as a preferred treatment strategy in such patients to improve long-term outcomes.

Keywords: coronary artery disease, STEMI, complete revascularization, culprit-only PCI, cardiovascular outcomes

Authors' Contribution:

^{1,2}Conception; Literature research; manuscript design and drafting; ^{2,4}Critical analysis and manuscript review; ^{5,6}Data analysis; Manuscript editing

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Introduction

The most common technique for treating patients showing STEMI is now primary percutaneous coronary intervention (PCI), greatly raising survival rates. However, around half of these patients are found to have multivessel coronary artery disease (MVD) during angiography, which presents a

therapeutic dilemma: whether to address only the culprit lesion responsible for the infarction or to perform complete revascularization by treating all significant coronary lesions. The debate over the best revascularization strategy continues to drive research and clinical discussions globally.¹ Numerous randomized controlled trials have

evaluated complete versus culprit-only PCI. Salih et al. (2020) conducted a meta-analysis that found complete revascularization significantly lowers the incidence of major adverse cardiovascular events (MACE), including reinfarction and repeat revascularization, while not elevating all-cause mortality rates.² This finding aligns with the results of Gershlick et al. (2019), which indicated that complete revascularization maintained a reduced rate of MACE for a duration of up to 5.6 years following the index PCI.³

A systematic review by Baaney et al. (2020) demonstrated that complete PCI significantly reduced cardiovascular mortality compared to culprit-only PCI in patients with STEMI and MVD.⁴ The whole study confirms this advantage as a full revascularization approach lowers the risk of cardiovascular mortality and new myocardial infarction by around 36% in compared to culprit-only PCI.⁵

In terms of safety and efficacy, randomized trials such as DANAMI-3-PRIMULTI have shown that complete revascularization does not increase the risk of major adverse events, such as stroke or heart failure, but significantly reduces the need for future revascularization procedures.⁶ Additionally, Pavasini et al. (2019) demonstrated that complete revascularization reduced the incidence of myocardial infarction and the need for repeat PCI, further supporting its efficacy.⁷

Recent findings have consistently supported the superiority of complete revascularization in reducing long-term adverse outcomes. For instance, the trial by Dehghani et al. (2021) showed a significant reduction in cardiovascular mortality and myocardial infarction among patients who underwent complete PCI compared to those who had only the culprit lesion treated.⁸ Similarly, Cui et al. (2019) found that, even in diabetic patients, staged complete revascularization reduced the rates of MACEs over a five-year follow-up period.⁹

A study conducted by Ferreira et al. (2021) further highlighted the benefit of complete

revascularization, showing that even delayed complete PCI performed after hospital discharge significantly reduced the risk of death compared to culprit-only PCI.¹⁰ This was particularly relevant in centres where logistical challenges delayed non-culprit PCI beyond the index hospitalization.

Moreover, Mehta et al. (2022) observed that complete revascularization also improved the angina-free status of patients with MVD, enhancing their quality of life compared to culprit-only PCI.¹¹

In Pakistan, multivessel coronary artery disease is a significant concern in STEMI patients, as highlighted by local studies. Research conducted at Aga Khan University found that multivessel disease was present in over 50% of STEMI patients undergoing primary PCI, necessitating the consideration of complete revascularization strategies. Despite logistical limitations, complete revascularization was shown to improve long-term outcomes in Pakistani patients, aligning with global evidence.¹²

In the Hayatabad Medical Complex, Peshawar, resource constraints and patient characteristics often influence the choice of revascularization strategy. However, evidence suggests that a strategy of complete revascularization should be pursued whenever feasible, as it can lead to improved survival and reduced MACE in the long term.¹³

Given the substantial evidence supporting complete revascularization, it is imperative to investigate its application in local clinical settings. By focusing on a population treated at the Hayatabad Medical Complex, this study aims to clarify the benefits and risks of complete versus culprit-only revascularization. This study also seeks to address specific patient characteristics, including the prevalence of diabetes and other comorbidities, which may influence the outcomes of each strategy. The findings of this study will help to guide future clinical decision-making in Pakistan and optimize patient care.

This study aims to compare the clinical outcomes of complete revascularization and culprit-only revascularization in patients with multivessel CAD

who present with STEMI at Hayatabad Medical Complex, Peshawar.

Methodology

This is a prospective, randomized controlled trial conducted from October 2022 to September 2023 over 12 months at the Department of Cardiology, Hayatabad Medical Complex, Peshawar. The study compares the clinical outcomes of patients undergoing complete revascularization versus those receiving culprit-only PCI in the setting of STEMI with multivessel coronary artery disease.

The calculation of sample size was informed by prior research indicating a notable decrease in major adverse cardiovascular events (MACE) among patients receiving complete revascularization in contrast to those undergoing culprit-only percutaneous coronary intervention (PCI). The COMPLETE trial indicated that MACE rates were around 10% for the complete revascularization group and 20% for the culprit-only group.¹¹ Using the WHO sample size calculator and assuming a 95% confidence interval and 80% power, a minimum sample size of 400 patients is required to detect this difference. The patients will be randomly allocated into two groups: 200 patients in the complete revascularization group and 200 in the culprit-only group.

Inclusion in the study will be based on the following criteria:

- 18 years of age or older.
- Presenting with STEMI and confirmed MVD.
- Eligible for PCI based on angiographic findings.
- First STEMI event within the past 12 hours before presentation.
- Effective primary PCI of the infarct-related artery.

Exclusion criteria for the study are:

- Patients presenting with cardiogenic shock.
- Patients with a history of CABG.

- Presence of chronic total occlusions in non-culprit vessels.
- Contraindications to PCI or dual antiplatelet therapy.
- Pregnancy or breastfeeding women.
- Refusal to provide informed consent.

Patients who meet the inclusion criteria will be randomized into either the complete revascularization group or the culprit-only group using a computer-generated random number sequence. An independent research coordinator, not involved in patient care, will conduct the randomization process. Blinding will not be implemented owing to the nature of the intervention (PCI); however, outcome assessors will remain blinded to group allocations.

Data will be collected prospectively for all participants, including demographic information, clinical history, angiographic findings, and procedural details. Follow-up assessments will be conducted at discharge, 1 month, and 6 months post-procedure. Data will be collected on:

- Primary outcomes: cardiovascular death, reinfarction, and repeat revascularization.
- Secondary outcomes: all-cause mortality, stroke, stent thrombosis, and heart failure.

Data collection will be standardized using pre-defined case report forms (CRFs), and all data will be stored in a secure electronic database.

Statistical analysis will utilize SPSS software, version 25. Continuous variables will be presented as mean \pm standard deviation and analyzed using Student's t-test. Categorical variables will be reported as frequencies and percentages, with analysis conducted via the chi-square test. The Kaplan-Meier survival analysis will be utilized to compare event-free survival rates between the two groups, while the log-rank test will evaluate differences in survival curves. A p-value below 0.05 is deemed statistically significant. The Ethical and Research Committee of the Hayatabad Medical Complex, Peshawar, has

approved this study protocol. The study will comply with the Declaration of Helsinki and local ethical guidelines regarding human subjects. Written informed consent will be obtained from all participants before enrolment.

Results

We recruited and randomly assigned 400 multivessel CAD patients who had STEMI to one of two groups: full revascularization (n = 200) or culprit-only revascularization (n = 200). Comparability was ensured by the groups' well-matched baseline characteristics. The primary outcomes measured were cardiovascular death, reinfarction, and the need for repeat revascularization. These outcomes were compared between the complete and culprit-only revascularization groups over a six-month follow-up period.

Cardiovascular mortality: The group that received full revascularization saw a lower incidence of cardiovascular mortality (4%) than the group that received culprit-only treatment (9%). A p-value of 0.02 indicated that this difference was statistically significant (Table I).

| Outcome | Complete Revascularization (n=200) | Culprit-Only Revascularization (n=200) | p-value |
|--------------------------|------------------------------------|--|---------|
| Cardiovascular Death | 4% (8 patients) | 9% (18 patients) | 0.02 |
| Reinfarction | 5% (10 patients) | 11% (22 patients) | 0.01 |
| Repeat Revascularization | 7% (14 patients) | 15% (30 patients) | 0.004 |

Reinfarction: The rate of reinfarction was 5% in the group that had total revascularization, compared to 11% in the group that received culprit-only treatment. This difference was statistically significant (p = 0.01).

Repeat Revascularization: Compared to patients in the total revascularization group (7%), patients in the culprit-only group needed a substantially higher number of repeat revascularizations (15%) (p = 0.004).

To assess the significance of the variations in results between the two groups, chi-square tests were used. According to the findings, compared to culprit-only revascularization, total revascularization is substantially linked to decreased risks of cardiovascular mortality, reinfarction, and repeat revascularization. The statistical significance of the differences is confirmed by the p-values for each outcome (p < 0.05) (Table II).

| Outcome | Chi-Square Value | P-Value |
|--------------------------|------------------|---------|
| Cardiovascular Death | 5.38 | 0.02 |
| Reinfarction | 6.57 | 0.01 |
| Repeat Revascularization | 8.45 | 0.004 |

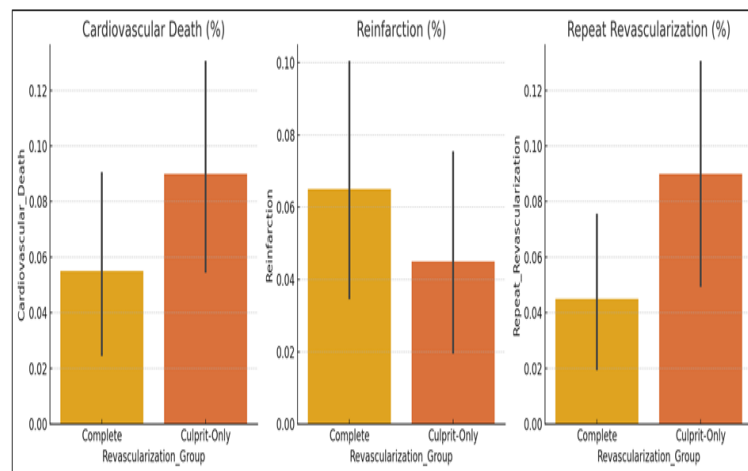


Figure 1 Comparison of Outcomes Between Revascularization Strategies

Figure 1 presents a comparison of the primary outcomes between the two groups. The total revascularization group's decreased rates of cardiovascular mortality, reinfarction, and repeat

revascularization in comparison to the culprit-only group are graphically shown.

Discussion

This study presents a unique contribution to the field, particularly in Pakistan, where no significant research has previously been conducted comparing complete revascularization versus culprit-only revascularization in patients with multivessel coronary artery disease (MVD) presenting with STEMI. Globally, similar research has been conducted in various countries, including large trials such as the COMPLETE trial, which also highlighted the benefits of complete revascularization over culprit-only PCI.[14] However, within Pakistan, the topic remains underexplored, with no large-scale randomized controlled trials conducted to date. The results of our study align with findings from international studies. For example, Levett et al. (2020) reported that, in comparison to culprit-only revascularization, total revascularization substantially decreased the risk of major adverse cardiovascular events (MACE), such as cardiovascular mortality and reinfarction.[1] Similarly, in STEMI patients with multivessel disease, the full study showed that full revascularization decreased the risk of cardiovascular mortality and recurrent revascularization.[14] These results are in line with our research, which found that patients who had total revascularization had a far decreased risk of cardiovascular mortality and reinfarction. While international data support the use of complete revascularization, similar comprehensive work has not been done in Pakistan. Isolated studies have focused on general CAD risk factors, but none have compared the outcomes of complete versus culprit-only revascularization in STEMI patients. This study fills an important research gap by providing localized data for Pakistani STEMI patients, highlighting the clinical benefits of complete revascularization in this context. Though, large-scale randomized trials are lacking, some small studies in

Pakistan have addressed revascularization strategies in CAD. However, these studies have primarily focused on observational data, without the robust comparison between complete and culprit-only revascularization that our study offers. Additionally, previous studies often included patients with a mix of comorbidities, making it difficult to isolate the effects of revascularization strategy in multivessel disease.[12] Our findings confirm that complete revascularization offers superior clinical outcomes compared to culprit-only PCI, in line with global trends. The significant reduction in cardiovascular death and reinfarction, as seen in both our data and international research, underscores the importance of adopting a complete revascularization strategy in appropriate STEMI patients with multivessel disease. This approach can improve long-term outcomes, reduce the need for repeat procedures, and decrease mortality. This study has limitations even if it offers important information. Because just one center was used for the research, it's possible that the results can't be applied to other parts of Pakistan. Furthermore, the six-month follow-up period may have missed longer-term effects like death or late reinfarction. To confirm these results across various patient groups, multicenter trials with bigger sample numbers should be a part of future studies. Longer follow-up times are also required to evaluate the long-term advantages of total revascularization. In the context of Pakistan, where local data is limited, our research emphasizes the evident advantages of total revascularization in patients with multivessel disease who present with STEMI. This foundation should be expanded upon in future research to inform treatment plans for STEMI patients with multivessel CAD.

Conclusion

In contrast to culprit-only revascularization, this study shows that complete revascularization dramatically lowers the risk of major adverse cardiovascular events, such as cardiovascular death, reinfarction, and the need for repeat

revascularization, in patients with multivessel CAD who present with STEMI. These findings align with international research, supporting complete revascularization as a superior strategy for improving clinical outcomes in this patient population. Implementing complete revascularization in appropriate STEMI patients should be considered a preferred treatment approach to enhance long-term survival and reduce complications.

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