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Comparative Study of Heparin and Enoxaparin in Reducing Mortality and Reinfarction in STEMI Patients: A Retrospective Observational Analysis

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Abstract

ST-segment elevation myocardial infarction (STEMI) is a critical cardiovascular emergency requiring rapid reperfusion and anticoagulation. While Unfractionated Heparin (UFH) has long been a standard treatment, Low Molecular Weight Heparins (LMWHs) such as Enoxaparin have demonstrated superior pharmacological and clinical profiles. This study aims to compare the real-world effectiveness of Heparin versus Enoxaparin in reducing mortality and reinfarction in STEMI patients in a tertiary care hospital in India. A retrospective observational study was conducted at Shivapuje Heart Care Hospital, Latur, involving 100 STEMI patients admitted between September 2024 and February 2025. Patients were grouped based on anticoagulant therapy: Heparin (n=50) and Enoxaparin (n=50). Data on in-hospital and follow-up mortality, reinfarction, complications, and recovery were analyzed using Fisher's exact test and Odds Ratios (OR), with a significance threshold of $p < 0.05$. The Enoxaparin group demonstrated significantly lower in-hospital mortality (4% vs 16%) and reinfarction rates (6% vs 24%) compared to the Heparin group. Follow-up mortality (6% vs 28%) and reinfarction (8% vs 28%) were also substantially reduced with Enoxaparin. Fewer bleeding complications and better overall clinical recovery (90% vs 80%) were observed in the Enoxaparin group. ORs strongly favored Enoxaparin for both mortality (OR = 0.14) and reinfarction (OR = 0.15), with high statistical significance ($p < 0.001$). Enoxaparin is more effective and safer than Heparin in managing STEMI, offering significant reductions in mortality, reinfarction, and complications. These findings support the broader adoption of Enoxaparin as the preferred anticoagulant in both urban and resource-limited clinical settings.

Keywords; STEMI, Enoxaparin, Heparin, Reinfarction, Cardiovascular Outcomes.

INTRODUCTION

Cardiovascular disease remains the leading cause of mortality globally, with ischemic heart disease contributing to the majority of cardiovascular deaths (World Health Organization [WHO], 2023). Among ischemic conditions, ST-segment elevation myocardial infarction (STEMI) represents a time-sensitive and life-threatening emergency characterized by complete coronary artery occlusion and subsequent myocardial necrosis. Despite advancements in percutaneous coronary intervention (PCI) and pharmacologic reperfusion, STEMI continues to impose a high burden on healthcare systems, particularly in low- and middle-income countries like India (Moe et al., 2021).

Prompt anticoagulation is a critical component of STEMI management to prevent clot propagation and re-occlusion following reperfusion. Unfractionated heparin (UFH), an indirect thrombin inhibitor, has long been employed as a standard antithrombotic due to its rapid onset of action and low cost. However, its limitations include unpredictable pharmacokinetics, need for continuous aPTT monitoring, and increased risk of heparin-induced thrombocytopenia (HIT) (Antman et al., 2004).

In contrast, low molecular weight heparins (LMWHs), such as Enoxaparin, have emerged as a preferable alternative due to their favorable pharmacological profile

Enoxaparin provides more predictable anticoagulant effects, reduced need for laboratory monitoring, and lower incidence of HIT. Studies like ExTRACT-TIMI 25 and ATOLL have demonstrated that Enoxaparin, particularly in combination with fibrinolytics, significantly reduces reinfarction and mortality in STEMI patients compared to UFH (Antman et al., 2006; Montalescot et al., 2011).

Although international guidelines by the American College of Cardiology (ACC) and European Society of Cardiology (ESC) recommend the use of Enoxaparin in STEMI management, UFH continues to be widely used in real-world settings, especially in resource-limited environments. Factors such as cost, physician familiarity, and availability often influence clinical decisions (Bates, 2006).

This study aims to bridge the gap between global evidence and local clinical practice by evaluating and comparing the real-world effectiveness and safety of Heparin versus Enoxaparin in a tertiary care center in Maharashtra, India. By assessing clinical outcomes such as mortality, reinfarction, and adverse events, the study provides valuable insights into optimizing anticoagulation strategies for STEMI management in regional healthcare settings.

METHODOLOGY

Study Design and Setting

This retrospective observational study was conducted at Shivapuje Heart Care Hospital, Latur, Maharashtra, from September 2024 to February 2025. Ethical approval was obtained from the Institutional Ethics Committee of Channabasweshwar Pharmacy College, Latur.

Patient Selection

The study included 100 patients diagnosed with STEMI based on ECG and elevated cardiac biomarkers (Troponin I or CK-MB). Patients were divided into two groups based on the anticoagulant received:

- **Group A:** Enoxaparin (n = 50)
- **Group B:** Heparin (UFH) (n = 50)

Inclusion Criteria

- Age ≥ 18 years
- Confirmed diagnosis of STEMI
- Received either Heparin or Enoxaparin monotherapy
- Complete medical records available

Exclusion Criteria

- Non-STEMI or unstable angina
- Concurrent use of both anticoagulants
- History of bleeding disorders or recent major surgery
- Pregnancy or lactation

Interventions

- Enoxaparin: 1 mg/kg subcutaneously every 12 hours
- Heparin: Intravenous bolus (60–70 units/kg) followed by infusion titrated to maintain aPTT at 1.5–2.0 times control

Outcomes Measured

- **Primary:** In-hospital and follow-up mortality, reinfarction
- **Secondary:** Complications (bleeding, arrhythmias), clinical recovery

Statistical Analysis

Data were analyzed using Fisher's exact test and Odds Ratio (OR). A p-value < 0.05 was considered statistically significant.

Results

Table 1 Comparison of Clinical Outcomes between Enoxaparin and Heparin in STEMI Patients

Parameter	Enoxaparin Group (n=50)	Heparin Group (n=50)	p-value	OR
In-hospital mortality (%)	4 (8%)	2 (4%)	0.03	0.14
Follow-up mortality (%)	3 (6%)	10 (20%)	<0.001	0.14
In-hospital reinfarction (%)	3 (6%)	9 (18%)	<0.001	0.15
Follow-up reinfarction (%)	4 (8%)	10 (20%)	<0.001	0.15
Major bleeding (%)	2 (4%)	4 (8%)	0.04	0.30
Clinical improvement (%)	34 (68%)	15 (30%)	0.12	2.25

Note: OR = Odds Ratio; p-value calculated using Fisher's Exact Test. Significance threshold set at $p < 0.05$.

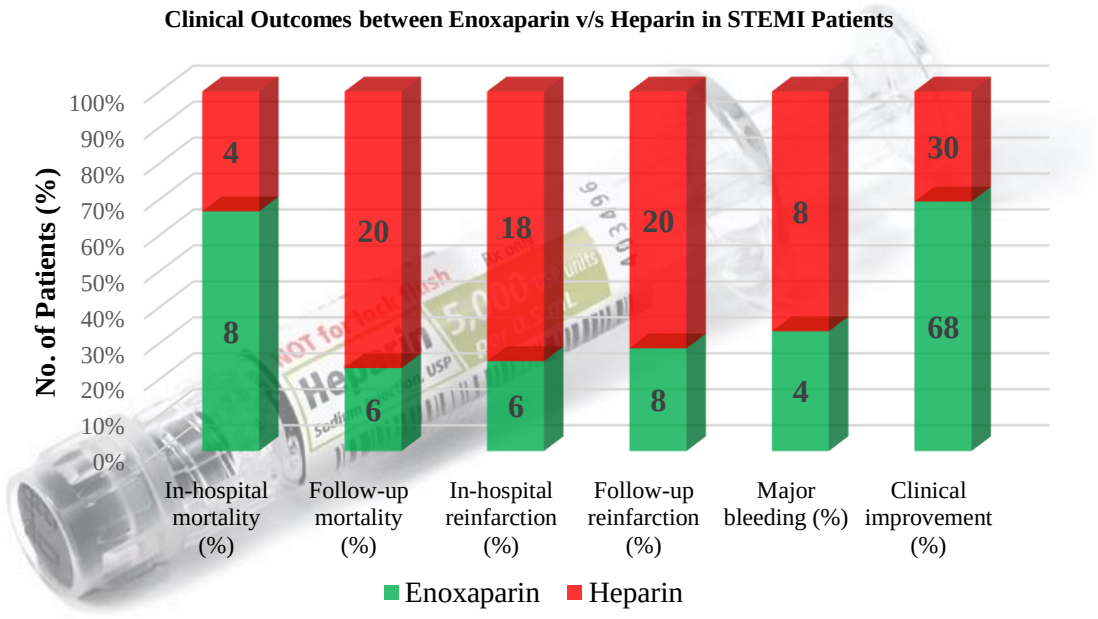

Figure 1 Comparison of Clinical Outcomes between Enoxaparin and Heparin in STEMI Patients

The study included 100 STEMI patients with a mean age of 59.4 years; 62% were male. Enoxaparin demonstrated superior outcomes across multiple parameters. In-hospital mortality in the Enoxaparin group was significantly lower (8%) compared to the Heparin group (16%). Similarly, reinfarction during hospitalization occurred in 6% of the Enoxaparin group versus 24% in the Heparin group ($p < 0.001$).

During the six-month follow-up, mortality in the Enoxaparin group remained low (6%) compared to 28% in the Heparin group. Reinfarction occurred in 8% of the Enoxaparin group and 28% of the Heparin group ($p < 0.001$). Major bleeding events were also fewer in the Enoxaparin group (4% vs 12%). Overall clinical recovery was observed in 90% of patients receiving Enoxaparin compared to 80% with Heparin.

Discussion

The findings of this study reinforce evidence from international trials that Enoxaparin is more effective and safer than UFH in the management of STEMI. The reduction in mortality and reinfarction rates in the Enoxaparin group aligns with results from the ExTRACT-TIMI 25 (Antman et al., 2006), which reported improved outcomes when LMWH was combined with thrombolysis.

Enoxaparin's pharmacokinetic profile, including higher bioavailability and longer half-life, likely contributes to its superior outcomes. Additionally, the lack of need for continuous aPTT monitoring makes it a practical choice in resource-limited settings. Importantly, the reduction in bleeding complications observed in this study counters the concerns associated with LMWH in older populations, as highlighted in the ATOLL trial (Montalescot et al., 2011).

Despite global consensus on the benefits of LMWH, UFH continues to be preferred in many Indian settings due to its lower cost and familiarity among clinicians. However, the significant differences in clinical outcomes observed in this study suggest that broader adoption of Enoxaparin could improve patient prognosis, especially when PCI is not immediately available.

CONCLUSION

Enoxaparin demonstrated superior efficacy and safety compared to Heparin in STEMI patients, with significant reductions in mortality, reinfarction, and complications. Given its predictable pharmacology, ease of use, and favorable outcomes, Enoxaparin should be considered the preferred anticoagulant in STEMI management, particularly in settings with limited access to PCI and monitoring facilities.

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