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Comparison of Rivaroxaban Versus Warfarin in Resolution of Left Ventricular Thrombus After Acute Anterior Wall Myocardial Infarction: A Prospective Cohort Study

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ABSTRACT

There is emerging evidence that direct oral anticoagulants like rivaroxaban are a more effective alternative for thrombus resolution after acute myocardial infarction. **Objective:** To compare the rate of left ventricular thrombus resolution between rivaroxaban and warfarin after acute anterior wall myocardial infarction. **Methods:** This prospective cohort study was conducted in the Department of Cardiology at Sheikh Zayed Hospital, Rahim Yar Khan, from May to November 2025. A total of 290 participants with left ventricular thrombus after acute anterior wall myocardial infarction were enrolled in the study. The unexposed group consisted of patients treated with warfarin, with the dose adjusted to maintain an INR of 2.0-3.0. The exposed group received rivaroxaban (20 mg daily; 15 mg if creatinine clearance was 30–50 ml/min/1.73m2). Echocardiography was performed at baseline and repeated after three months to assess thrombus resolution. Data were analyzed through SPSS version 25.0. Descriptive statistics were run, and an independent sample t-test was used for numerical comparison and a chi-square test for categorical comparison. **Results:** The mean age was 60.4 ± 6.4 years, with 73.4% males. Baseline demographics were comparable between the groups. Thrombus resolution at three months was achieved in 52.4% overall, significantly higher in rivaroxaban versus warfarin (61.4% vs. 43.4%, p-value=0.002; RR: 1.4, 95% CI: 1.1–1.8). Diabetes, hypertension, and thrombus size ≥1 cm were associated with lower thrombus resolution rates. **Conclusions:** Rivaroxaban demonstrated better efficacy over warfarin for thrombus resolution in post-myocardial infarction patients. Comorbid diabetes, hypertension, and larger thrombosis size were significant negative predictors of resolution.

INTRODUCTION

Patients with left ventricular systolic dysfunction are more likely to experience left ventricular thrombosis (LVT), mostly a fatal condition that typically develops between 1 day and 2 weeks following myocardial infarction (MI) [1]. A significant 10–40% chance of MI, acute stroke, distal embolism, and other severe cardiovascular incidents is linked to the establishment of LVT [2]. LVT is seen in 3–7% cases with significant LV dysfunction and may increase up to 20-22% in individuals with ST-elevation myocardial infarction (STEMI), even though its prevalence has declined in comparison to the pre-thrombolytic era [3]. Warfarin and other vitamin K antagonists (VKAs) are common anticoagulant medications used to treat LVT, in cases of an international normalised ratio (INR) of 2-3, during treatment [4]. The family of Direct Oral Anticoagulants (DOACs) includes the direct factor Xa inhibitor rivaroxaban. It can be used to treat non-valvular atrial fibrillation, pulmonary embolism (PE), and deep vein thrombosis (DVT). Rivaroxaban's use in preventing atherothrombotic events after acute coronary syndrome (ACS) is one of its noteworthy features [5]. Compared to VKAs, DOACs—like rivaroxaban—have fewer dietary and medication interactions, less chance of cerebral haemorrhage, less need for frequent monitoring, and improved drug

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adherence, making them promising therapies for LVT [6]. Only diverse retrospective observational studies have evaluated the safety and effectiveness of DOACs in treating LVT in individuals presenting with acute coronary syndrome (ACS) [7, 8]. Mansouri et al. enrolled 52 patients with ACS, equally divided into rivaroxaban and warfarin groups (26 patients each). The thrombus resolution rates in the rivaroxaban (76.9%) and warfarin (69.2%) groups, as well as the thrombus size reduction, did not show any major difference between the two groups [9]. Prajapati et al. studied 21 cases in the Warfarin group and 19 patients in the Rivaroxaban group. Three months after the treatment initiation, thrombus resolution in the rivaroxaban group was 47.7% vs. 33.4% in the warfarin group [10]. Current study was planned to assess the efficacy of rivaroxaban versus warfarin in managing LVT in patients with ACS. Identifying a more effective and safer anticoagulant will reduce the risk of embolic complications, improving patient outcomes after anterior wall MI. If rivaroxaban proves superior or non-inferior to warfarin, it will lead to updated treatment guidelines, simplifying LVT management. Reducing hospital visits for INR monitoring will ease the burden on healthcare systems and enhance patient convenience. We hypothesized that the thrombus resolution rate in three months would be higher in rivaroxaban compared to warfarin after acute anterior wall myocardial infarction.

There is limited evidence comparing the efficacy and safety of rivaroxaban with the traditionally used warfarin for the management of left ventricular thrombus (LVT) following acute coronary syndrome, particularly after anterior wall myocardial infarction. Warfarin therapy also requires frequent INR monitoring, which increases the burden on both patients and healthcare systems. Therefore, this study aimed to assess the efficacy of rivaroxaban compared with warfarin in the management of LVT in patients with acute coronary syndrome.

METHODS

This prospective cohort study was conducted at the Department of Cardiology of Sheikh Zayed Hospital, Rahim Yar Khan. Participants were enrolled in the study over a period of six months from 21st May 2025 to 20th November 2025, through consecutive sampling. The study was conducted after approval from the institutional ethics committee (ERC#145-/IRB/SZMC/SZH; Dated 23rd April, 2025). A total of 290 participants, 40-80 years of age, either male or female gender, admitted to the hospital due to left ventricular thrombus after acute anterior wall myocardial infarction, were included in the study after written informed consent. Participants with a history of clotting disorder, antiphospholipid syndrome, atrial fibrillation, deep venous thrombosis, pulmonary embolism, on anticoagulation therapy, estimated GFR < 30 mL/min/1.73m^2, platelet count < 50,000/mm3, chronic liver disease, pregnant and breastfeeding women were excluded from the study. Patients were managed according to routine clinical practice, and the decision to prescribe rivaroxaban or warfarin was made by the treating physician in consultation with the patient, based on clinical judgment, patient preference, and drug availability. The standard/unexposed group consisted of the patients treated with Warfarin, and the exposed group was the patients treated with Rivaroxaban. After enrolment, baseline characteristics of participants, including age, gender, obesity, diabetes, hypertension, and smoking, were recorded. All the participants had baseline transthoracic echocardiography performed by a consultant cardiologist to confirm the presence and size of the thrombus before starting thrombolytic therapy. Dual antiplatelet therapy was prescribed to all the participants as per hospital protocol. All the patients in the warfarin group had baseline prothrombin time (PT) and international normalized ratio (INR) measured before starting treatment. The initial dose of 5 mg was titrated to keep INR between 2.0 and 3.0. The patients in the exposed group were prescribed 20 mg of rivaroxaban once daily at bedtime. The dose was reduced to 15 mg if creatinine clearance was between 30 - 50 mL/min/1.73m^2. The treatment was continued for three months with fortnightly follow-ups. All patients were verbally inquired about adverse drug reactions during each follow-up visit. After treatment, echocardiography was repeated by the same operator, not aware of the thrombolytic treatment given. The status of thrombus resolution was recorded. The primary outcome was defined as complete thrombus resolution, characterized by the absence of any visible thrombus on follow-up echocardiography. The same predefined criteria were applied consistently to all participants to ensure standardized, transparent outcome assessment. Safety assessment was limited to major adverse events, specifically stroke, pulmonary embolism, and deep vein thrombosis, identified through scheduled clinical follow-up and review of hospital records [10]. These outcomes were defined as clinically diagnosed and are imaging-confirmed events. A sample size of 290 patients, 1:1 ratio of both groups, was calculated assuming 47.7% thrombus resolution in the rivaroxaban and 33.4% in the warfarin thrombolysis treatment groups at 80% power of the study and 5% significance level. The sample size was calculated through the OpenEpi online software using the cohort study formula: $n = \frac{(Z_{\alpha/2} + Z_{1-\beta})^2 \bar{p}\bar{q}(r+1)}{r(p_1 - p_2)^2}$.

The data were analysed through SPSS version 25.0. Normality of age and thrombus size was assessed using the Shapiro–Wilk test, and as both variables followed a normal distribution, they were summarized as mean ± standard deviation. Frequency and percentages are reported for

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categorical data. Between-group comparisons are made using an independent sample t-test for numerical data and a chi-square test for categorical data. Relative Risk with 95% confidence interval is calculated to identify factors associated with complete thrombus resolution. For all the comparisons, p-value <0.05 is considered significant. To estimate adjusted relative risks (aRR) for complete thrombus resolution, a multivariable generalized linear model with a log link function and binomial distribution was applied. Adjusted relative risk and their 95% confidence intervals were derived directly from the model coefficients. Covariates included in the multivariable model were selected a priori based on clinical relevance and variables demonstrating a p-value < 0.20 in univariate analysis. Statistical significance of individual predictors was assessed using Wald chi-square statistics. To assess potential multicollinearity among predictors, variance inflation factors (VIFs) were examined. A VIF>10 was considered indicative of significant collinearity. No substantial multicollinearity was detected in the final model. This study was conducted and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for observational research.

RESULTS

The mean age of the participants was 60.4 ± 6.4 years, with 56.2% (n=163) 60 years and above. There were 73.4% (n=213) male patients. Obesity was prevalent in 26.6% (n=77), diabetes in 40.3% (n=117), hypertension in 44.1% (n=128), and smoking in 43.4% (n=126) of the patients. The mean thrombus size was 11.3 ± 5.0 mm, with 56.2% (n=163) having a thrombus size of one cm or above. The demographic characteristics were comparable between the warfarin and rivaroxaban thrombolysis therapy groups. No hospital-acquired infection during hospital stay was observed. No adverse drug reactions or adverse events (stroke, pulmonary embolism, DVT) were observed during the follow-up (Table 1).

Table 1: Characteristics of Patients with Left Ventricular Thrombus After Acute Anterior Wall Myocardial Infarction (n=290)

Characteristic	Overall (n=290)	Warfarin Group (n=145)	Rivaroxaban Group (n=145)	p-value*
Age (years)	60.4 ± 6.4	59.9 ± 6.6	60.9 ± 6.1	0.188[a]
< 60-years old	127 (43.8%)	67 (52.8%)	60 (47.2%)	0.407[b]
≥ 60-years old	163 (56.2%)	78 (47.9%)	85 (52.1%)	
Gender – Male	213 (73.4%)	107 (50.2%)	106 (49.8%)	0.894[b]
Female	77 (26.6%)	38 (49.4%)	39 (50.6%)	
Obesity – Yes	77 (26.6%)	36 (46.8%)	41 (53.2%)	0.506[b]
Diabetic – Yes	117 (40.3%)	58 (49.6%)	59 (50.4%)	0.905[b]
Hypertensive – Yes	128 (44.1%)	62 (48.4%)	66 (51.6%)	0.636[b]
Smoker – Yes	126 (43.4%)	64 (50.8%)	62 (49.2%)	0.813[b]
Thrombus size (mm)	11.3 ± 5.0	11.6 ± 5.5	11.0 ± 4.5	0.318[a]
< 1 cm	127 (43.8%)	65 (51.2%)	62 (48.8%)	0.723[b]
≥ 1 cm	163 (56.2%)	80 (49.1%)	83 (50.9%)	

*Independent sample t-test for numerical comparison and chi-square for categorical b comparison

Three months after treatment, thrombus resolution was achieved in 52.4% (n=152) of all the participants. Rate of thrombus resolution was significantly higher in the rivaroxaban group compared to warfarin (61.4% vs. 43.4%, p-value=0.002) (Figure 1).

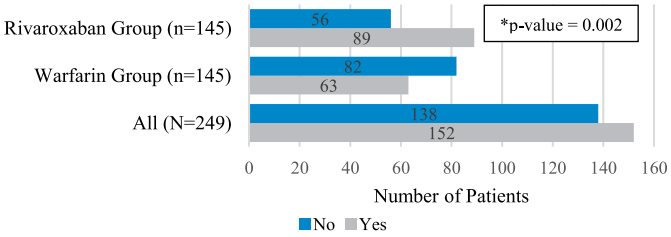

Figure 1: Thrombus Resolution After Three Months in Study Participants (n=290)
*chi-square test

Compared to warfarin therapy, the relative risk of thrombus resolution was significantly higher in rivaroxaban treatment [61.4% vs. 43.4%: RR (95%CI): 1.4 (1.1 – 1.8), p-value = 0.003]. Compared to patients without diabetes, the relative risk of thrombus resolution was significantly lower in diabetics [40.2% vs. 60.7%: RR (95%CI): 0.66 (0.5 – 0.9), p-value <0.001]. Compared to patients without hypertension, the relative risk of thrombus resolution was significantly lower in hypertensive patients [41.4% vs. 61.1%: RR (95%CI): 0.67 (0.5 – 0.8), p-value <0.001]. Incidence of thrombus resolution was significantly lower in thrombus size ≥ 1 cm compared to <1cm [28.8% vs. 82.7%: RR(95%CI): 0.35(0.3 – 0.5), p-value <0.001] (Table 2).

Table 2: Factors Associated with Thrombus Resolution in Patients with Left Ventricular Thrombus After Acute Myocardial Infarction (n=290)

Associated Factors		Thrombus Resolution		Relative Risk (95% CI)	p-value
		Yes	No		
Treatment	Rivaroxaban	89 (61.4%)	56 (38.6%)	1.4 (1.1 – 1.8)	0.003*
	Warfarin	63 (43.4%)	82 (56.6%)		
Age groups	< 60-year	72 (56.7%)	55 (43.3%)	1.2 (0.9 – 1.4)	0.195
	≥ 60-year	80 (49.1%)	83 (50.9%)		
Gender	Male	106 (49.8%)	107 (50.2%)	0.8 (0.6 – 1.1)	0.116
	Female	46 (59.7%)	31 (40.3%)		
Obesity	Yes	34 (44.2%)	43 (55.8%)	0.8 (0.6 – 1.1)	0.110
	No	118 (55.4%)	95 (44.6%)		
Diabetes	Yes	47 (40.2%)	70 (59.8%)	0.66 (0.5 – 0.9)	<0.001*
	No	105 (60.7%)	68 (39.3%)		
Hypertension	Yes	53 (41.4%)	75 (58.6%)	0.67 (0.5 – 0.8)	<0.001*
	No	99 (61.1%)	63 (38.9%)		
Smoker	Yes	61 (48.4%)	65 (51.6%)	0.87 (0.7 – 1.1)	0.238
	No	91 (55.5%)	73 (44.5%)		

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Thrombus Size	≥ 1cm	47 (28.8%)	116 (71.2%)	0.35 (0.3 – 0.5)	<0.001*
	< 1cm	105 (82.7%)	22 (17.3%)		

*chi-square test, significant p-value

Five independent predictors were identified in the multivariable model, including treatment as the primary exposure variable. Thrombus resolution was 3.7 (1.9 – 7.1) times higher in the rivaroxaban group compared to warfarin. Thrombus size of ≥ 1cm [aRR: 0.07 (0.03 – 0.14)], smoking [aRR: 0.29 (0.15 – 0.58)], hypertension [aRR: 0.27 (0.14 – 0.54)], and diabetes [aRR: 0.43 (0.23 – 0.78)] were significant negative predictors of thrombus resolution (Table 3).

Table 3: Independent Predictors of Thrombus Resolution in Patients with Left Ventricular Thrombus After Acute Myocardial Infarction(n=290)

Independent Predictors		Adjusted Relative Risk (95% CI)	Wald chi-square	p-value
Treatment	Rivaroxaban	3.7 (1.9 – 7.1)	16.1	<0.001*
	Warfarin	1		
Thrombus Size	≥ 1cm	0.07 (0.03 – 0.14)	56.7	<0.001*
	< 1cm	1		
Smoking	Yes	0.29 (0.15 – 0.58)	12.3	<0.001*
	No	1		
Hypertension	Yes	0.27 (0.14 – 0.54)	14.1	<0.001*
	No	1		
Diabetes	Yes	0.43 (0.23 – 0.78)	7.6	<0.006*
	No	1		

*Significant p-value

DISCUSSION

In our study, we found that three months after treatment, thrombus resolution was achieved in almost half of all the participants. The rate of thrombus resolution was significantly higher in the rivaroxaban group compared to warfarin. LVT is very common after STEMI, even though it can happen in conditions other than infarction. The increased risk of embolization and ischemic stroke makes medical management of LVT extremely difficult. One of the key components of managing LVT is anticoagulation therapy. For the treatment of post-ACS, LVT, current guidelines (ESC, ACCF/AHA) mainly recommend using VKAs (warfarin) for a maximum of three to six months [11]. At the same time, individuals who have poor warfarin compliance are recommended to take DOACs. However, the off-label use of DOACs among patients with LVT has increased recently due to no dietary limitations, the lack of frequent monitoring requirements, and the absence of various drug interactions associated with warfarin [12]. In a pilot randomized research, Jenab Y et al found that after 3-months, full LVT resolution was 76.0% with rivaroxaban and 54.2% with warfarin (RR ~1.40). In both groups, significant bleeding and embolic episodes were uncommon [13]. Zhang *et al.* demonstrated comparable or quicker LVT resolution in an observational cohort of patients receiving rivaroxaban-based triple treatment as compared to VKA-based regimens; bleeding and clinical outcomes were tolerable [7]. In comparison to VKAs, DOACs (including rivaroxaban) were linked to comparable or superior thrombus resolution and decreased bleeding/stroke risk, according to a meta-analysis of observational studies conducted by Shrestha *et al.* [14]. This pooled evidence supports our results. A comparative cohort analysis of DOACs versus VKAs for post-myocardial infarction LVT was carried out by Attachaipanich *et al.* In post-MI patients, they found that DOACs were associated with reduced risks of stroke and systemic embolism and greater LVT resolution rates than warfarin [15]. Their results also support our findings that rivaroxaban outperforms warfarin in terms of resolution at three months. Rivaroxaban lowers the period of insufficient anticoagulation that can obstruct thrombus resolution by providing rapid, predictable anticoagulation without the INR instability and dietary/drug interactions of warfarin [16]. Because DOACs don't require monitoring visits, they frequently increase adherence, which in turn results in more constant anticoagulation and greater resolution rates. In the present study, we observed that diabetes, hypertension, and thrombus size ≥1 cm were associated with lower thrombus resolution rates. At three months, Yang *et al.* discovered that a large thrombus was independently linked to a higher probability of thrombus persistence or recurrence (OR ~1.11 per unit increase). Persistence was also predicted by ventricular aneurysm and mural texture [17]. Despite anticoagulation, larger (≥1 cm) thrombi persist because they are more likely to be chronic or mural and are mechanically more difficult to lyse. In an observational research, Lu *et al.* found that characteristics of larger/older thrombi and elevated inflammatory markers (such as CRP) were associated with a decreased chance of early thrombus clearance. According to the authors, comorbid disorders that worsen inflammation and hinder healing also decrease remission [18]. It is conceivable that diabetes and hypertension decrease anticoagulant-mediated thrombus resolution because they are pro-inflammatory and pro-thrombotic conditions (and frequently linked to elevated CRP). In a similar study, a review and pooling of data by Kim *et al.* revealed that thrombus size/area, ventricular aneurysm presence, decreased LVEF, and inflammatory markers predicted persistence; comorbidities that resulted in endothelial dysfunction, such as diabetes and poorly controlled hypertension, were reported as significant predictors for delayed thrombus resolution [19]. LVT size was found to be an independent predictor of thrombus persistence by Ahmed *et al.* Concurrent antiplatelet

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medication aided in resolution; a bigger thrombus area was strongly associated with non-resolution [20]. Patients with type-2 diabetes had poorer cardiovascular outcomes overall, according to a retrospective analysis by Shi *et al.* There was evidence of greater adverse events and possibly various types of responses to anticoagulant methods in LVT subgroups [21]. Microvascular disease, chronic inflammation, poor fibrinolysis, and platelet hyperactivity associated with diabetes may all decrease thrombus clearance and raise the chance of recurrence [22]. Current study's prospective cohort design and well-defined inclusion and exclusion criteria were its strengths. For statistical analysis to be significant, the sample size (n=290) was sufficient. In a real-world post-MI setting, rivaroxaban and warfarin were directly compared head-to-head.

Standardized follow-up evaluation was ensured using echocardiography at baseline and three months. Some of the limitations of our study were that it was a single-center study, which may limit generalizability. The imaging modality used was echocardiography, which is less sensitive than cardiac MRI for thrombus detection despite being more practical. Because of the comparatively brief follow-up (three months), long-term recurrence, embolic events, or bleeding problems might not have been detected. As treatment allocation was determined by physician judgment and patient preferences rather than randomization, the study is subject to potential selection bias and residual confounding. Although this pragmatic approach reflects real-world clinical practice, differences in baseline characteristics are unmeasured factors between groups may have influenced outcomes, thereby limiting the internal validity and causal inference of the findings. Minor bleeding events were not systematically captured as predefined study outcomes. Therefore, while no thromboembolic complications were observed, the absence of recorded bleeding events should not be interpreted as absence of bleeding risk. In the future, large multi-center randomized controlled studies will be required to confirm that rivaroxaban is superior to warfarin in a variety of populations. Future research should use cardiac MRI to detect and characterize thrombus more precisely. Studies with longer follow-up (6–12 months) should be carried out to evaluate the risk of bleeding, embolic events, recurrence, and durability of thrombus clearance.

CONCLUSIONS

We concluded that rivaroxaban was more effective than warfarin in resolving left ventricular thrombus after acute anterior wall myocardial infarction. However, diabetes, hypertension, and larger thrombus size significantly reduced resolution rates, highlighting the need for individualized management and further large-scale, randomized studies. This study was conducted for academic and research purposes to generate preliminary evidence in a real-world clinical setting. The findings should be interpreted cautiously and are not intended to be directly replicated or implemented as a definitive treatment strategy without further validation through larger, more well-designed studies, ideally randomized controlled trials.

Authors' Contribution

Conceptualization: MZS
Methodology: MZS, JNN, SAF
Formal analysis: AM, JNN, MKR
Writing and Drafting: MZS, AM
Review and Editing: MZS, AM, JNN, MKR, SAF

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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