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original article

Echocardiographic Outcomes of Prolonged Balloon Inflation during Stent Deployment Strategy in Primary Percutaneous Coronary Intervention for ST-Segment Elevation Myocardial Infarction

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Abstract

Background: Acute coronary syndrome (ACS) often serves as the initial clinical sign of coronary artery disease (CVD), and in ST-elecvation myocardial infarction (STEMI) cases, primary percutaneous coronary intervention (PPCI) is the preferred strategy for reperfusion, provided it is administered promptly. **Methods:** The investigation enrolled 152 cases diagnosed with STEMI, all recommended for PPCI. These cases were allocated into two groups: Group I, the Prolonged Balloon Stent Inflation Group (PBSG), and Group II, the Conventional Deployment Stent Group (CDSG). Echocardiographic evaluations were conducted at baseline, immediately after PPCI on the first hospital day, and again at six months. **Results:** In primary outcomes, transient no-reflow occurred in 3 cases (3.9%) in Group I and 12 cases (15.7%) in Group II (P=0.03). More than 50% resolution of ST-segment elevation was noticed in 71 cases (93.4%) from Group I and 59 cases (77.6%) from Group II (P=0.011). Regarding secondary outcomes, both mean EF (P=0.002) and mean WMSI (P=0.001) showed significant improvements from baseline in both groups during follow-up, with a notable difference between the groups. In the LAD subgroup, there were similar improvements in mean EF (P<0.001) and mean WMSI (P<0.001), with a statistically significant difference between the two groups. **Conclusion:** Six months after PPCI, significant improvements in global and segmental LV wall motion were noted in STEMI cases, particularly in those who underwent PBS, as opposed to those who received CDS.

Keywords: PPCI; Prolonged ballon inflation; Ejection Fraction; WMSI; No-reflow.

Introduction

Cardiovascular diseases (CVDs) have consistently been the leading global cause of mortality for several decades, presenting a major challenge to public health worldwide. In 2021, an alarming 20.5 million people died from cardiovascular conditions, accounting for nearly 1/3 of all global deaths. This marked a sharp increase from the 12.1 million CVD-related deaths noticed in 1990, underscoring the urgent need for better prevention, healthcare interventions, and increased global awareness about cardiovascular risks. Moreover, a disproportionate burden of CVD-related deaths falls on low- and middle-income countries, where limited healthcare access

exacerbates the impact of these diseases on the population [1,2,3]

While chest pain is the most commonly recognized symptom of acute myocardial infarction (AMI), recent studies show that women are more likely to exhibit a range of additional, less obvious signs. These non-chest pain manifestations can be more challenging to detect, leading to potential delays in diagnosis and timely intervention for acute coronary syndrome (ACS) in women. [4–7] Failure to quickly identify these symptoms can result in delays in diagnosis, presentation, and the timely administration of treatment for ACS in women, ultimately leading to adverse health outcomes. Several studies have emphasized that women with ACS are less frequently diagnosed accurately, are less likely to receive the appropriate guideline-based treatment,[8-10] and are less likely to undergo coronary revascularization when required.[11,12]

The pathophysiology of ACS is often dynamic, meaning that cases may quickly progress from one clinical condition (such as unstable angina, non-ST elevation (NSTEMI), or ST elevation (STEMI) myocardial infarction [STEMI]) to another throughout their presentation, evaluation, and initial treatment. [13]

This investigation aimed to evaluate the impacts of prolonged balloon inflation during stent deployment on echocardiographic outcomes in percutaneous coronary intervention (PPCI) for STEMI.

Patients and Methods

This study was a comprehensive prospective, single-center investigation carried out at the Cardiac Care Unit (CCU) and catheterization unit within the Cardiology Department at "Benha University Hospital," conducted over an extended period from November 1, 2022, to October 31, 2024 (spanning a full 24 months). A total of 200 cases initially met the inclusion criteria for the investigation; however, due to various exclusion factors, 48 cases were eventually excluded. These exclusions were as follows: 12 cases required urgent referral for coronary artery bypass grafting (CABG), 11 cases experienced persistent no-reflow conditions, and 25 cases were excluded because they did not complete the follow-up process. Consequently, the final investigation population was comprised of 152 cases, allocated into two distinct groups according to their treatment strategies:

- Group I (76 cases): Cases undergoing Prolonged Stent Deployment .
- Group II (76 cases): Cases undergoing Conventional Stent Deployment .

Inclusion Criteria:

Cases included in the investigation were individuals aged 18 years or older, diagnosed with STEMI and referred for PPCI within 12 h of symptom onset. Eligible cases presented with ST-segment elevation of at least 1 mm in at least two contiguous leads, a presumed new left bundle branch block, or a confirmed posterior myocardial infarction (MI). Admission to the hospital had to occur either within 12 h of symptom onset, or within a 12 to 24-hour window, provided there was clear evidence of ongoing ischemia during the clinical evaluation.

Exclusion Criteria:

Cases were excluded from the investigation if they met any of the following criteria: unsuccessful PPCI or non-PCI coronary vessels, previous thrombolysis treatment, a history of prior MI, prior CABG surgery, a diagnosis of cardiomyopathy, severe valvular heart disease, the presence of malignant arrhythmias, congenital heart disease,

chronic obstructive pulmonary disease with poor echocardiographic windows, or cases who exhibited poor cooperation during the investigation.

Methodology:

The methodology of this investigation was designed to ensure the collection of accurate and reliable data for analysis. All cases underwent a detailed and comprehensive history-taking process. The personal history included demographic details such as name, age, sex, occupation, and residence. Additionally, the investigation investigated common risk factors for cardiovascular disease, including diabetes mellitus, hypertension, smoking habits, dyslipidemia, as well as any history of renal or cardiac disorders and other relevant health conditions.

- **Clinical examination:**

A thorough clinical examination was then performed, which included both general and local cardiac examinations to assess any visible or palpable signs that might inform diagnosis and management.

- **Electrocardiography (ECG):**

Electrocardiography (ECG) was conducted for all participants, utilizing a standard 12-lead ECG to evaluate key parameters such as heart rate, rhythm, and the presence of any underlying abnormalities or irregularities in electrical conduction.

- **Echocardiography:**

Additionally, all cases underwent echocardiographic evaluation on the first day of their in-hospital stay, immediately after PPCI. The cases were examined in the left lateral decubitus position, in accordance with the American Society of Echocardiography's guidelines, and were connected to a single-lead ECG. This allowed for a comprehensive evaluation of the patient's cardiac function. Key measurements included left ventricular ejection fraction (LVEF), which provides an indicator of overall cardiac efficiency [14]. The wall motion score index (WMSI) was calculated as the sum of all individual segment scores, divided by the number of segments visualized[15,16]. Diastolic function was also assessed to understand the heart's ability to relax and fill properly during the diastolic phase [17]. The severity of mitral regurgitation was evaluated, and the function of the right ventricle was assessed using Tricuspid Annular Plane Systolic Excursion (TAPSE)[18].

All initial echocardiographic data were carefully documented, and after 6 months, follow-up echocardiography was conducted following the same procedures to assess any changes in the cases' condition over time.

- **Interventional Data:**

Interventional procedures were performed using standard left heart catheterization and coronary angiography, with access achieved via either the femoral or radial artery, depending on the patient's condition and clinical needs. Coronary perfusion was evaluated using the TIMI flow grading system to assess the effectiveness of blood flow within the coronary vessels, and any complications occurring during the procedure were meticulously documented. The extent of coronary artery disease (CAD) was classified into categories of single-vessel, two-vessel, or multi-vessel disease, with the goal of performing complete revascularization during the same session whenever possible. The severity of coronary stenosis was visually assessed during PCI, providing an immediate evaluation of the lesion and its response to treatment. Participants were randomly assigned to one

of two groups: PBSG or CDSG. Various drug-eluting stents, including Resolute Onyx, Xience Expedition, and Xience Alpine, were used in the procedure. Additionally, intracoronary vasodilators, glycoprotein IIb/IIIa inhibitors, and aspiration catheters (Export Advance) were utilized as needed to optimize the procedural outcomes and minimize complications such as distal embolization or no-reflow.[19]

- **Follow up:**

After a six-month period, comprehensive follow-up assessments were conducted for all participants to evaluate any potential changes in their cardiac function. The follow-up process involved several key evaluations, starting with a resting 12-lead ECG, which was performed to closely monitor any alterations in the heart's electrical activity, helping to identify any arrhythmias or other abnormalities. In addition to the ECG, a 2D echocardiography was carried out to assess various aspects of heart function, including left ventricular ejection fraction (LVEF), regional wall motion, and diastolic function. These follow-up measurements were carefully compared with the baseline echocardiographic data, which had been collected during hospital admission. This comparison allowed for a thorough examination of any changes in the participants' cardiac function over the six-month period, providing valuable insights into the long-term effects of the treatment and intervention.

Ethical design:

Ethical integrity was paramount throughout the course of this investigation. Informed consent was carefully and thoroughly obtained from all participants, ensuring that they had a clear understanding of the procedures involved, as well as the potential risks and benefits associated with their participation. Every effort was made to ensure transparency and protect the rights and well-being of the participants. The investigation was formally approved by the Ethics Committee of Benha University (MD: 6-10-2022), with additional authorization granted by the Dean of the Faculty of Medicine and the administrators of Benha University Hospitals

Statistical analysis

The data collected during the investigation were analyzed using IBM SPSS software (version 20.0) (Armonk, NY: IBM Corp, released 2011). Categorical data were presented as counts and percentages, while continuous data were described with range, mean, standard deviation, median, and interquartile range (IQR). Data normality was assessed using the Kolmogorov-Smirnov test, and statistical significance was set at 5%. The analysis included Chi-square for categorical variables, Fisher’s Exact test when more than 20% of cells had expected counts below five, Student’s t-test for normally distributed quantitative variables, and Mann-Whitney test for non-normally distributed variables.

Results

The present investigation included 152 cases diagnosed with STEMI who were recommended for primary PCI. These cases were divided into two groups: PBSG and CDSG. Transthoracic echocardiography was carried out on all cases at baseline, on the first day of their in-hospital stay immediately following PCI, and was repeated 6 months after PPCI, spanning the period from November 2022 to October 2024.

Regarding gender distribution, there was a male predominance in both groups. In Group I, the mean number of males was 66 (86.6%) and females 10 (13.2%), whereas in Group

II, was 52 (68.4%) and females 24 (31.6%). A statistically significant difference was noted (P=0.006), indicating a higher percentage of females in Group II.

The mean age of cases in PBSG Group was 54.96 ± 12.31 years, while in Group II, it was 56.45 ± 13.31 years, with comparable values between the two groups.

Regarding medical history, smoking was the most common risk factor, affecting a mean of 92 cases (60.5%). Specifically, 56 cases (73.7%) in PBSG Group and 36 cases (47.4%) in CDSG group were smokers. This difference was statistically significant (P=0.001), indicating a higher prevalence of smoking in Group I.

All cases underwent revascularization with DES, and DCBs were employed for complete (non-culprit) revascularization in 12 cases (7.89%). In total, 209 stents and 13 DCBs were employed. The distribution of stents was as follows: 105 cases (69.07%) received one stent, 37 cases (24.34%) received two, and 10 cases (6.57%) received more than three. For DCBs, 11 cases (7.32%) received one, and only 1 patient (0.65%) received two. Both groups were comparable in terms of the number of DES or DCBs employed. **(Figure 1)**

Aspiration catheters were employed in a mean of 7 cases (4.60%), and tirofiban was administered to a mean of 21 cases (13.81%). Both groups were comparable regarding the use of these adjunctive treatments.

For the primary outcomes, persistent no-reflow occurred in 11 cases, leading to their exclusion from the investigation. Transient no-reflow was noted in a mean of 3 cases (3.9%) in PBSG Group and 12 cases (15.7%) in Group II, with a significant difference (P=0.03), indicating a higher incidence of transient no-reflow in Group II.

The mean ST-segment elevation resolution exceeded 50% from baseline in 71 cases (93.4%) from PBSG Group and 59 cases (77.6%) from Group II, with a significant difference (P=0.011), suggesting better resolution in Group I.

During the 6-month clinical follow-up, all 152 cases showed no hospital readmissions and no MACE, indicating favorable clinical outcomes for both groups

Echocardiogrphic data (main 2 groups) (Table 1)(Figure 2-7)

Echocardiographic data exhibited improvements in the mean LVEF and WMSI in both groups from baseline to follow-up. These improvements were statistically significant, with Groups I and II showing differences (P=0.002 for LVEF and P=0.001 for WMSI).

There was also improvement in DD grading and MR grading in both groups from baseline to follow-up, but both groups were comparable in these parameters.

Concerning RV function, assessed by TAPSE, comparable improvement was noticed in both groups from baseline to follow-up. Additionally, TAPSE measurements were comparable between the two groups.

Echocardiogrphic data (3 subgroups) (Table 2,3) (Figure 8,9)

We noticed variations in the compliance of different coronary arteries, suggesting potential subgroup differences. Three subgroup analyses were performed:

A) LAD Subgroup: Significant improvements in mean LVEF and mean WMSI were noticed (P<0.001 for both), indicating a clear impact of the treatment strategies.

B) LCX Subgroup: Improvements in mean LVEF and mean WMSI were noted, with comparable effects between the two groups.

C) RCA Subgroup: Improvements were also noticed in the RCA subgroup, with comparable effects between the two groups.

Table (1): Comparison between the two studied groups according to echocardiography outcomes

		Group I (n=76)	Group II (n=76)	Test of Sig.	p
EF %	**Baseline**				
	Min. – Max.	30.0 – 54.0	34.0 – 54.0	t=	0.654
	Mean ± SD.	42.66 ± 5.23	43.03 ± 4.87	0.450	
	Median (IQR)	42.0 (38.50 – 47.50)	42.0 (39.0 – 48.0)		
	Follow up				
	Min. – Max.	48.0 – 67.0	45.0 – 65.0	t=	0.002*
	Mean ± SD.	56.75 ± 4.15	54.34 ± 5.04	3.215*	
	Median (IQR)	58.0 (54.0 – 60.0)	54.50 (50.0 – 59.0)		
WMSI	**Baseline**				
	Min. – Max.	1.30 – 2.20	1.40 – 2.20	t=	0.779
	Mean ± SD.	1.76 ± 0.24	1.75 ± 0.22	0.281	
	Median (IQR)	1.80 (1.55 – 1.90)	1.80 (1.50 – 1.90)		
	Follow up				
	Min. – Max.	1.0 – 1.50	1.0 – 1.70	t=	0.001*
	Mean ± SD.	1.21 ± 0.14	1.30 ± 0.17	3.441*	
	Median (IQR)	1.20 (1.10 – 1.30)	1.30 (1.15 – 1.40)		
Lateral e` velocity (cm/s)	**Baseline**				
	Min. – Max.	5.0 – 7.0	5.0 – 7.0	t=	0.487
	Mean ± SD.	6.04 ± 0.82	6.13 ± 0.81	0.697	
	Median (IQR)	6.0 (5.0 – 7.0)	6.0 (5.0 – 7.0)		
	Follow up				
	Min. – Max.	6.0 – 9.0	6.0 – 9.0	t=	1.000
	Mean ± SD.	7.88 ± 0.77	7.88 ± 0.75	0.000	
	Median (IQR)	8.0 (7.0 – 8.0)	8.0 (7.0 – 8.0)		
E/A	**Baseline**				
	Min. – Max.	0.50 – 1.50	0.50 – 1.50	U=	0.595
	Mean ± SD.	0.76 ± 0.22	0.75 ± 0.24	2747.50	
	Median (IQR)	0.70 (0.60 – 0.90)	0.70 (0.60 – 0.90)		
	Follow up				
	Min. – Max.	0.40 – 1.20	0.40 – 1.20	U=	0.772
	Mean ± SD.	0.56 ± 0.12	0.56 ± 0.13	2816.00	
	Median (IQR)	0.50 (0.50 – 0.60)	0.50 (0.50 – 0.60)		
TAPSE	**Baseline**				
	Min. – Max.	13.0 – 25.0	13.0 – 25.0	t=	0.708
	Mean ± SD.	19.04 ± 2.62	18.88 ± 2.57	0.376	
	Median (IQR)	18.0 (17.0 – 21.0)	19.0 (17.0 – 21.0)		
	Follow up				
	Min. – Max.	15.0 – 23.0	15.0 – 23.0	t=	0.721
	Mean ± SD.	19.45 ± 1.53	19.54 ± 1.64	0.358	
	Median (IQR)	20.0 (19.0 – 20.0)	20.0 (18.50 – 20.50)		

IQR: **Inter quartile range** SD: **Standard deviation** **t: Student t-test**
U: Mann Whitney test p: p value for comparing between the two studied groups
*: Statistically significant at $p \leq 0.05$ **Group I:** Prolonged Stent Deployment
Group II: Conventional Stent Deployment

Table (2): Comparison between the three studied subgroups according to EF%

EF%	LAD		LCX		RCA	
	Group I (n=42)	**Group II (n=46)**	**Group I (n=13)**	**Group II (n=10)**	**Group I (n=21)**	**Group II (n=20)**

Baseline						
Min.–Max.	30.0 – 45.0	34.0 – 45.0	42.0 – 50.0	42.0 – 50.0	45.0 – 54.0	45.0 – 54.0
Mean± SD.	38.89 ± 2.94	39.55 ± 2.66	47.27 ± 2.49	46.67 ± 2.46	48.14 ± 2.48	48.50 ± 2.46
Median(IQR)	39.0 (37.0 – 40.50)	39.50 (38.0 –41.50)	48.0 (46.50 – 49.0)	47.50 (44.5–48.5)	48.0 (46.0 – 50.0)	48.0 (46.0 – 50.0)
t(p)	**1.102(0.274)**		**0.586(0.564)**		**0.463(0.646)**	
Follow up						
Min.–Max.	48.0 – 67.0	45.0 – 60.0	56.0 – 62.0	54.0 – 62.0	54.0 – 65.0	54.0 – 65.0
Mean ±SD.	54.86 ± 3.97	51.14 ± 3.71	59.55 ± 2.25	57.83 ± 2.76	59.24 ± 3.08	59.30 ± 2.70
Median(IQR)	54.50 (52.0 – 58.0)	50.50 (48.0 –54.0)	60.0 (58.0 – 62.0)	57.50 (55.5–60.0)	60.0 (58.0 – 62.0)	60.0 (58.0 – 61.0)
t(p)	**4.545*(<0.001*)**		**1.621(0.120)**		**0.068(0.946)**	
Difference (delta)						
Min. – Max.	10.0 – 32.0	7.0 – 18.0	10.0 – 14.0	7.0 – 14.0	8.0 – 14.0	8.0 – 14.0
Mean ± SD.	15.98 ± 3.74	11.59 ± 2.40	12.27 ± 1.56	11.17 ± 1.95	11.10 ± 1.55	10.80 ± 1.64
Median(IQR)	15.0 (14.0 – 17.0)	12.0 (10.0 – 13.0)	12.0 (11.0 – 14.0)	11.50 (10.0–12.50)	12.0 (10.0 – 12.0)	11.50 (9.50 – 12.0)
t(p)	**6.546*(<0.001*)**		**1.496(0.149)**		**0.593(0.557)**	

IQR: **Inter quartile range** SD: **Standard deviation**
t: Student t-test p: p value for comparing between the two studied groups

Table (3): Comparison between the three studied subgroups according to WMSI

WMSI	LAD		LCX		RCA	
	Group I (n=42)	**Group II (n=46)**	**Group I (n=13)**	**Group II (n=10)**	**Group I (n=21)**	**Group II (n=20)**
Baseline						
Min.–Max.	1.70 – 2.20	1.60 – 2.20	1.40 – 1.80	1.40 – 1.80	1.30 – 1.70	1.40 – 1.70
Mean ±SD.	1.93 ± 0.13	1.91 ± 0.12	1.55 ± 0.13	1.58 ± 0.13	1.51 ± 0.12	1.51 ± 0.10
Median(IQR)	1.90 (1.90 – 2.0)	1.90 (1.85 – 2.0)	1.50 (1.45 – 1.60)	1.55 (1.50 – 1.70)	1.50 (1.40 – 1.60)	1.50 (1.40 – 1.60)
t(p)	**0.554(0.349)**		**0.548(0.589)**		**0.132(0.895)**	
Follow up						
Min. – Max.	1.0 – 1.50	1.10 – 1.70	1.0 – 1.20	1.0 – 1.30	1.0 – 1.30	1.0 – 1.30
Mean ± SD.	1.28 ± 0.13	1.40 ± 0.11	1.11 ± 0.09	1.19 ± 0.11	1.13 ± 0.11	1.13 ± 0.10
Median(IQR)	1.30 (1.20 – 1.40)	1.40 (1.35 – 1.50)	1.10 (1.0 – 1.20)	1.20 (1.10 – 1.30)	1.10 (1.0 – 1.20)	1.10 (1.05 – 1.20)
t(p)	**4.939*(<0.001*)**		**1.940(0.066)**		**0.108(0.915)**	
Difference (delta)						
Min. – Max.	0.40 – 1.10	0.20 – 0.70	0.30 – 0.60	0.20 – 0.50	0.30 – 0.50	0.30 – 0.50
Mean ± SD.	0.66 ± 0.11	0.50 ± 0.10	0.44 ± 0.09	0.38 ± 0.08	0.38 ± 0.05	0.38 ± 0.07
Median(IQR)	0.60 (0.60 – 0.70)	0.50 (0.40 – 0.60)	0.40 (0.40 – 0.50)	0.40 (0.35 – 0.40)	0.40 (0.40 – 0.40)	0.40 (0.30 – 0.40)
t(p)	**6.704*(<0.001*)**		**1.446(0.163)**		**0.050(0.960)**	

IQR: **Inter quartile range** SD: **Standard deviation**
t: Student t-test
p: p value for comparing between the two studied groups
*: Statistically significant at $p \leq 0.05$

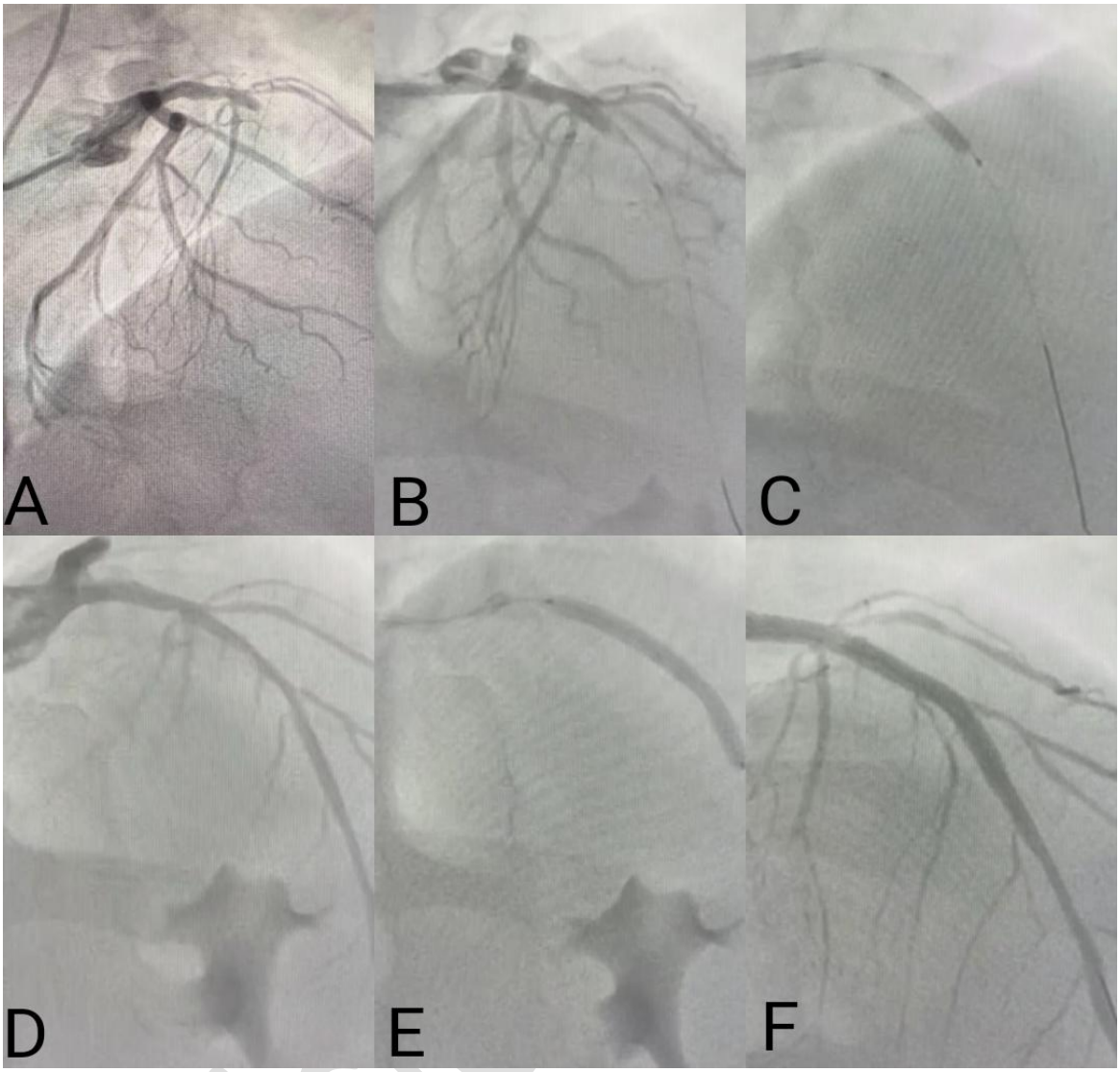

Figure (1): Coronary angiography for anterior STEMI patient no. 7 followed by PPCI steps. A) Baseline angiography revealed mid-segment total LAD occlusion. B) LAD wiring using BMW wire. C) Predilatation of the lesion using Maverick ballon 2.5 x20 mm at 10 ATM. D) Revealed significant long stenotic lesion with TIMI III distal flow. E) Xience Expedition stent 3.5 x 38 mm deployed and inflated at 12 ATM for 45s. F) Final angiographic satisfactory results with distal TIMI III flow.

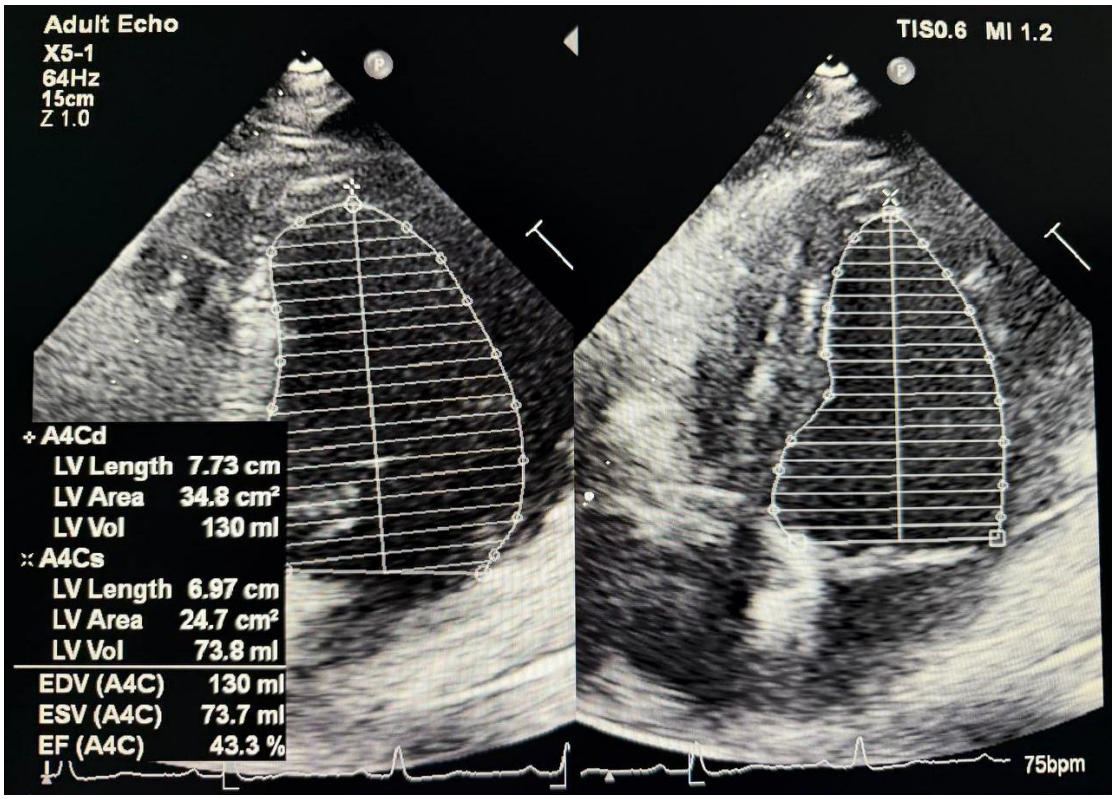

Figure (2): Apical four chamber view using modified biplane Simpson's method to assess EF % at baseline (1st day just after PPCI) in patient no. 7.

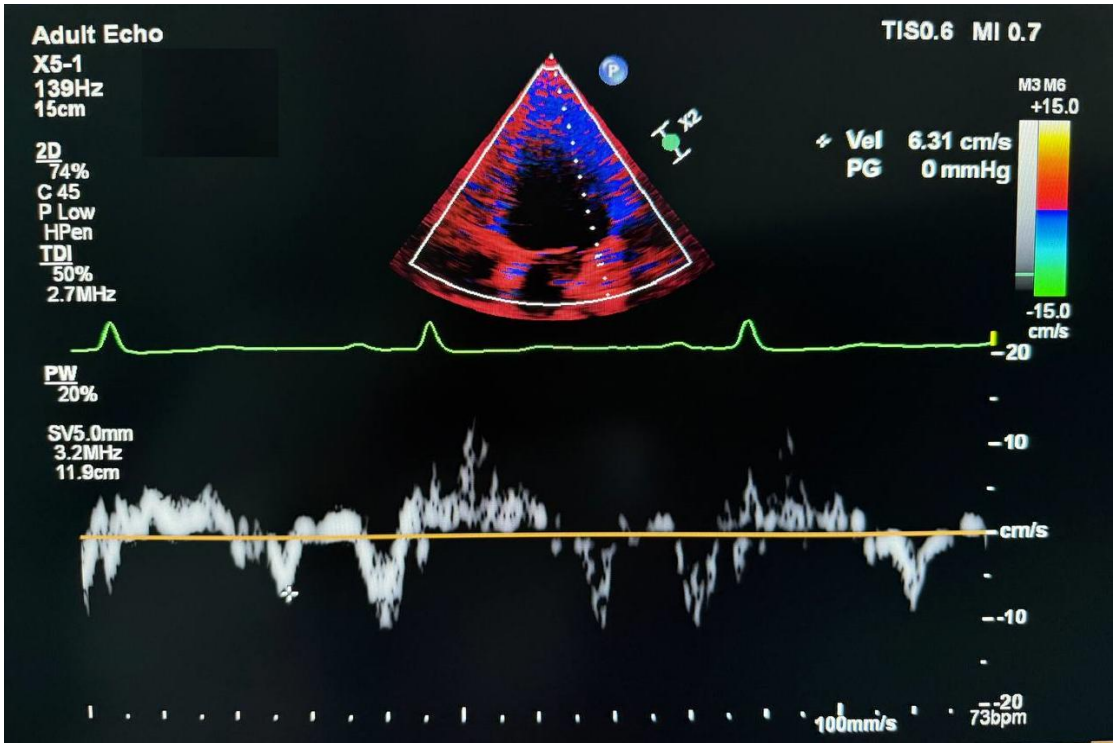

Figure (3): Colored Tissue Doppler on lateral mitral leaflet (cm/s) at baseline (1st day just after PPCI) in patient no. 7.

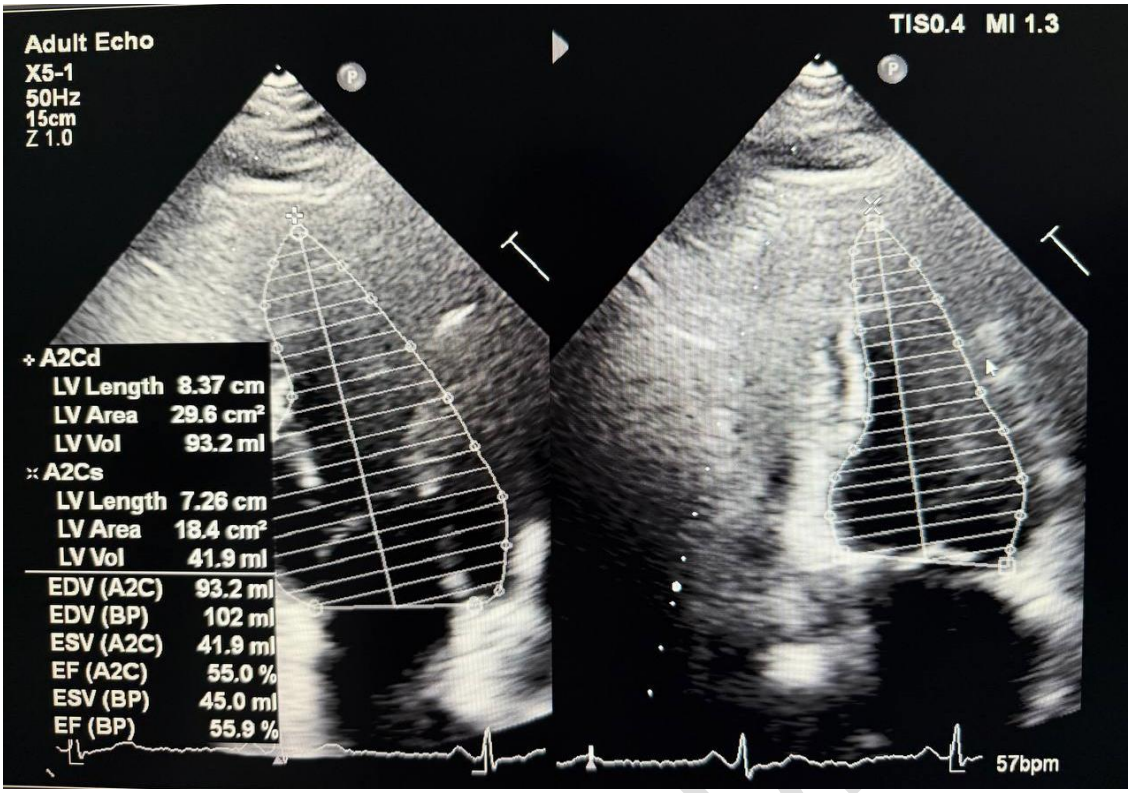

Figure (4): Apical four chamber view using modified biplane Simpson's method to assess EF % at 6 months follow up after PPCI in patient no. 7.

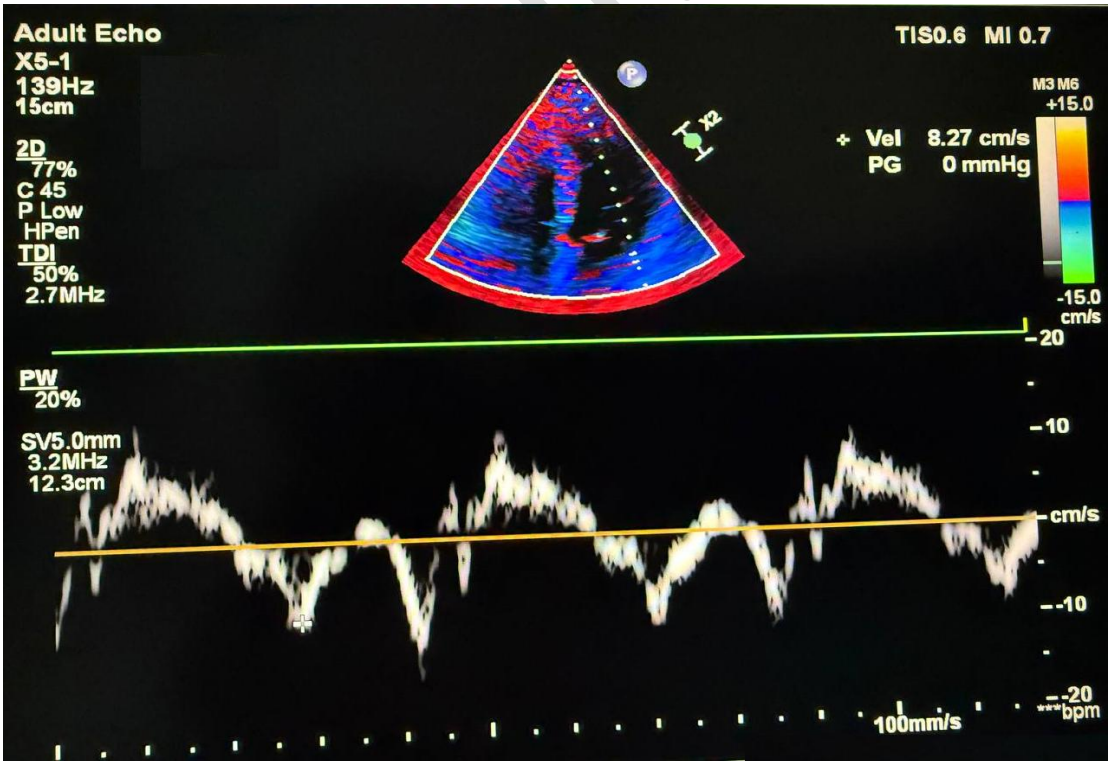

Figure (5): Colored Tissue Doppler on lateral mitral leaflet (cm/s) at 6 months follow up after PPCI in patient no. 7.

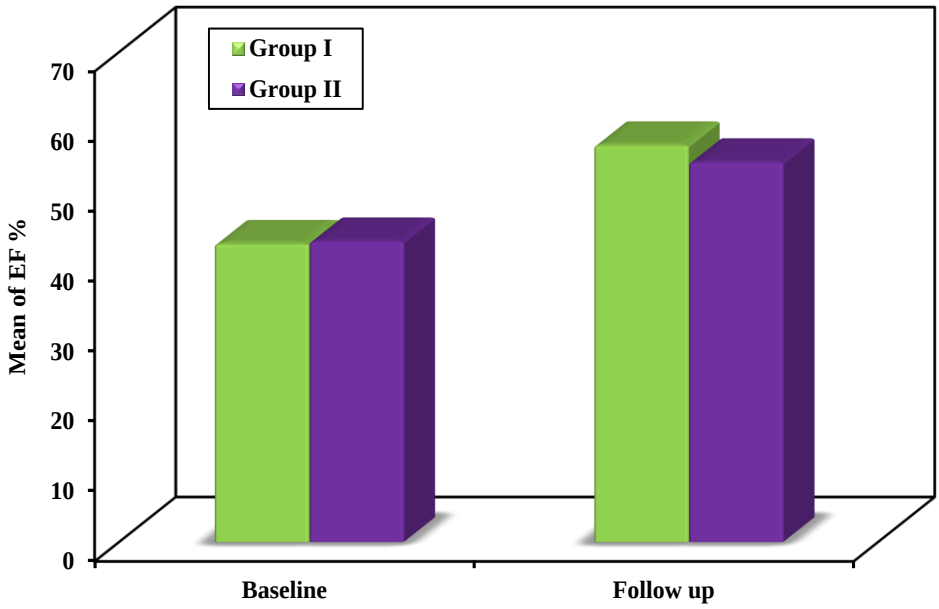

Figure (6): Comparison between the two studied groups according to EF %

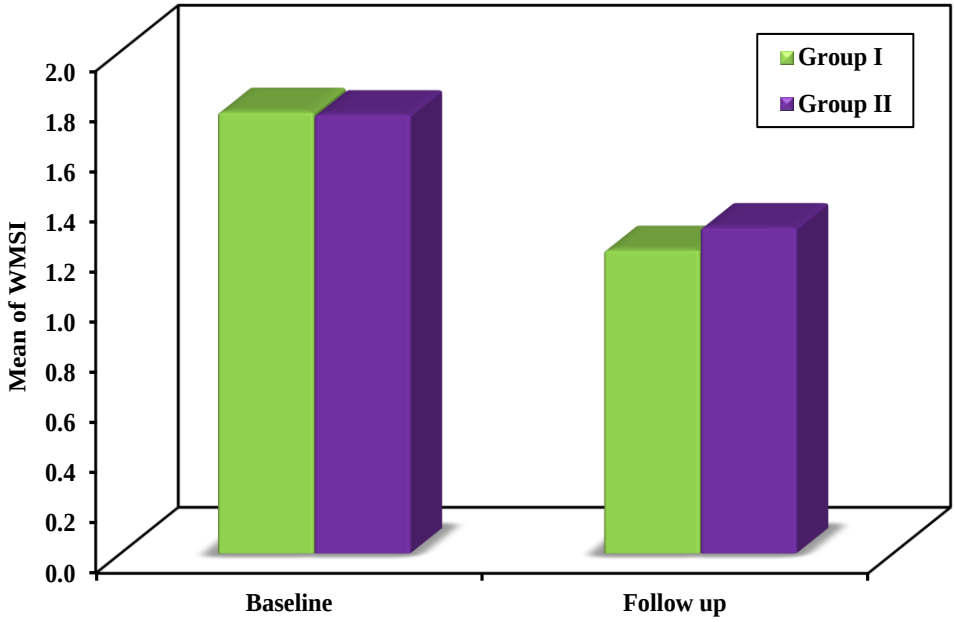

Figure (7): Comparison between the two studied groups according to WMSI

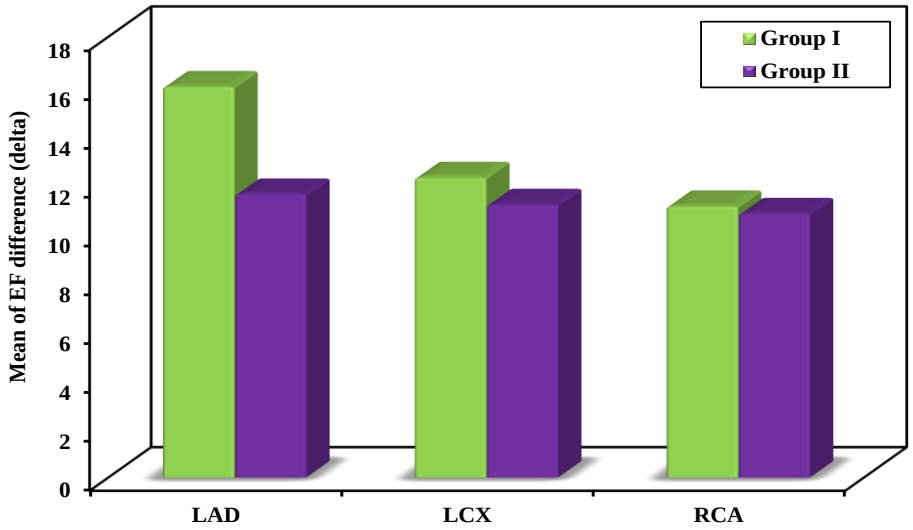

Figure (8): Comparison between the three studied subgroups according to EF% difference (delta)

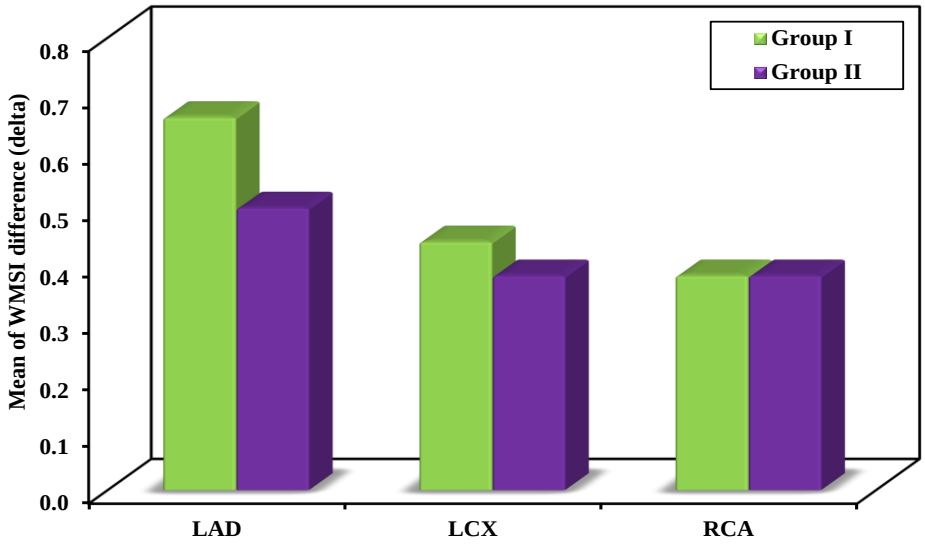

Figure (9): Comparison between the three studied subgroups according to WMSI difference (delta)

Discussion

This investigation represents the first attempt to assess the echocardiographic outcomes linked to prolonged balloon inflation during stent deployment in PPCI for STEMI. Several factors are believed to play a role in the occurrence of no-reflow, including balloon pressure, inflation duration, repeated balloon inflations, and the number of stents used during the procedure. These factors are thought to potentially influence the development of no-reflow. However, numerous retrospective studies have suggested that, despite their theoretical significance, these factors do not appear to have a major impact on the incidence of no-reflow. Specifically, in smaller vessels, it is hypothesized that the stent may act to anchor the thrombus to the vessel wall, especially in cases where the thrombus is more fibrous in

composition. This interaction may reduce the likelihood of further complications related to microvascular obstruction or no-reflow [20]

The duration of stent inflation is crucial for ensuring optimal stent expansion. Rapid inflation alone may not always be sufficient to achieve full expansion, which is essential for the stent to function effectively. A stent that reaches full expansion may potentially trap the atherothrombus beneath its struts, which could reduce the likelihood of distal embolization during PPCI. This hypothesis suggests that prolonged inflation might be beneficial in minimizing complications like embolization by securing the thrombus within the vessel. However, despite the clinical relevance of this concept, it remains underexplored in randomized controlled trials (RCTs), and further research is needed to validate the potential benefits of this approach [21,22]

In our investigation, the mean age in PBSG Group was 54.96 ± 12.31 years and in Group II, it was 56.45 ± 13.31 years, with no statistically significant difference. The investigation exhibited male predominance, with 77.7% males across the groups and a statistically significant difference (P=0.006). Similar findings were noted by Marwan et al [22,] who analyzed seven studies with a total of 341 cases and exhibited a weighted mean age of 67.6 ± 3.0 years, with 81.8 ± 6.2% being male. In contrast, Muhammad et al [23] exhibited that cases in the Prolonged Balloon Inflation Strategy Group (PBSG) had a mean age of 59.83 ± 10.10 years, while those in the Conventional Deployment Strategy Group (CDSG) had a mean age of 60.39 ± 10.16 years, revealing minimal age differences between the groups. The gender distribution was balanced, with 63 (51.6%) males and 59 (48.4%) females.

The most common risk factor in our investigation was smoking, noted in 92 cases (60.5%). Specifically, 56 cases (73.7%) from PBSG Group and 36 cases (47.4%) from CDSG group were smokers, with a statistically significant difference (P=0.001). This contrasts with the findings of Min Ma et al [24] who exhibited no predominance regarding diabetes mellitus (DM), hypertension (HTN), or smoking.

Focusing on the primary outcomes, we noticed transient no-reflow in 3 cases (3.9%) in Group I, and a higher incidence of 12 cases (15.7%) in CDSG group (P=0.03). Min Ma et al [24] in a investigation of 120 cases, exhibited that TIMI flow grade 3 was achieved in 96.7% of cases in the PBSG, in contrast to just 63.3% in the CDSG (P=0.005). The PBSG also exhibited a notably lower rate of no-reflow or slow flow when as opposed to the CDSG (0% vs. 30%, P=0.002). Echoing these findings, Muhammad et al[23] demonstrated that the PBSG had significantly fewer cases of immediate TIMI flow grades under 3 (4.9% vs. 26.2%, P=0.00) and no-reflow (0% vs. 26.2%, P=0.00).

In our analysis, we noticed that 71 cases (93.4%) from PBSG Group and 59 cases (77.6%) from CDSG group had more than a 50% reduction in ST-segment elevation from baseline, with a significant difference between the two groups (P=0.011). This is in line with Anil Potdar and Satyavan Sharma[25] findings, where more than 50% ST-segment resolution was seen in 62 cases (87.32%) from PBSG Group and 51 cases (71.83%) from Group II. Min Ma et al [24] also exhibited that the PBSG had a higher rate of ST-segment elevation resolution (90%) as opposed to the CDSG (66.7%, P=0.028). Similarly, Muhammad et al [23] exhibited that a greater proportion of cases in

the PBSG achieved ≥50% resolution (77.0% vs. 57.4%, P=0.02).

When assessing echocardiographic outcomes, both groups exhibited improvements in mean LVEF (P=0.002) and mean WMSI (P=0.001) from baseline to follow-up. In the LAD subgroup, there was a marked improvement in mean LVEF (P<0.001) and mean WMSI (P<0.001), showing a clear contrast between the two main groups. However, in the LCX and RCA subgroups, while improvements in mean LVEF were noted, there was no significant difference between the groups.

These observations align with the investigation by Anil Potdar and Satyavan Sharma [25], which demonstrated a significant improvement in mean LVEF, with an average increase ranging from 6.76% to 50.56%, with a margin of error of ±8.68%, over a 9-month follow-up period. Similarly, Min Ma et al [24] research , which focemployed on a subgroup of cases using CMR, revealed a stark difference in microvascular obstruction rates: 6.7% of cases in the PBSG had obstruction, as opposed to 50% in the CDSG (P=0.023).

Conclusion

LV global and segmental wall motion were significantly improved after PPCI in patients with STEMI , 6 months post-PPCI follow up especially in patients with prolonged stent deployment strategy compared with patients with conventional stent deployment strategy. On the other hand LAD, compared to LCX and RCA, was significantly improved using prolonged stent deployment strategy compared with patients with conventional stent deployment strategy.

Recommendations

Further studies are essential to prospectively identify the most effective PPCI strategy that would provide the maximum benefit for STEMI patients. Such studies could play a crucial role in optimizing treatment approaches, ensuring better outcomes for patients with STEMI. Additionally, the incorporation of more advanced techniques, such as strain imaging and speckle tracking, is recommended to achieve more accurate and detailed results in echocardiographic assessments. These methods could enhance the precision of evaluating cardiac function, ultimately improving clinical decision-making and treatment strategies.

Limitations

This investigation was conducted at a single center, which may limit the generalizability of the findings to other populations. Additionally, the relatively small sample size may have reduced the statistical power of the study, making it harder to detect subtle differences between groups. Furthermore, cases with persistent no-reflow were excluded from the analysis due to the inability to perform control angiography or CMR, which could have affected the comprehensiveness of the data and the overall conclusions of the study.

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List of abbreviations

2D	**:**	Two Dimensional
ACS	**:**	Acute Coronary Syndrome
AMI	**:**	Acute Myocardial Infarction
ATM	**:**	Atmosphere
BMW	:	Balanced Middle Weight
BMS	**:**	Bare Metal Stent
CABG	**:**	Coronary Artery Bypass Grafting
CAD	**:**	Coronary Artery Disease
CCU	:	Cardiac Care Unit
CDSG	**:**	Conventional Deployment Strategy Group
CMR	:	Cardiac Magnetic Resonance
CVD	**:**	Cardiovascular Disease
DCB	**:**	Drug Coated Ballon
DD	**:**	Diastolic Dysfunction
DES	**:**	Drug Eluting Stent
ECG	**:**	Electrocardiography
EF	**:**	Ejection Fraction
HF	**:**	Heart Failure
LAD	**:**	Left Anterior Descending
LCX	**:**	Left Circumflex
LV	**:**	Left Ventricle
LVEF	**:**	Left Ventricular Ejection Fraction
MACE	**:**	Major Adverse Cardiac Events
MI	**:**	Myocardial Infarction
NSTEMI	**:**	Non St-Elecvation Myocardial Infarction
PBSG	**:**	Prolonged Balloon Inflation Strategy Group
PCI	**:**	Percutaneous Coronary Intervention
PPCI	**:**	Primary Percutaneous Coronary Intervention
PW	**:**	Pulsed Wave
RCA	**:**	Right Coronary Artery
RV	**:**	Right Ventricle
STEMI	**:**	St-Elecvation Myocardial Infarction
TAPSE	**:**	Tricuspid annular plane systolic excursion
TDI	**:**	Tissue Doppler Imaging
TIMI	**:**	Thrombolysis In Myocardial Infarction
TTE	**:**	Transthoracic Echocardiography
WMS	**:**	Wall Motion Score
WMSI	**:**	Wall Motion Score Index