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Original Research Article

Assessment of Left Ventricular Function after Elective Percutaneous Coronary Intervention in Patients with Coronary Artery Disease with Compromised LV Function

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Abstract:

Objective: The objective of this study was to evaluate the extent of improvement in left ventricular (LV) function following elective percutaneous coronary intervention (PCI) in patients with coronary artery disease (CAD) with compromised LV function.

Methods: A total of 104 patients with CAD with compromised LV function were enrolled in this prospective study. Baseline characteristics, including LV ejection fraction (LVEF) and LV diastolic dysfunction (LVDD) grades, were recorded. All patients underwent elective PCI within a specific timeframe following the index event. Follow-up assessments were conducted at 3- and 6-months post-PCI to evaluate changes in LVEF and LVDD grades. Data analysis included descriptive statistics and comparison of mean values.

Results: The majority of patients underwent PCI on the Left Anterior Descending artery (LAD) (44.23%), followed by the Right Coronary Artery (RCA) (24.03%) and the Left Circumflex artery (LCX) (15.38%). In Group 1 (LVEF <30%), significant improvement in LVEF was observed from baseline (23.5%) to 3 months (30.5%) and 6 months (32.16%). In Group 2 (LVEF 30-40%), LVEF improved from baseline (33.7%) to 3 months (40.2%) and 6 months (42.16%). The prevalence of LVDD decreased over time, with improvements observed in LVDD grades. The timing of intervention showed a positive correlation with the degree of LV function improvement.

Conclusion: Elective PCI in patients with CAD and compromised LV function leads to significant improvements in LVEF and LVDD. Patients with severe LV systolic dysfunction showed substantial improvement within the initial 3 months, while those with moderate dysfunction displayed continued improvement over 6 months. Early intervention from the index event was associated with greater improvement in LV function. These findings emphasize the benefits of timely elective PCI in optimizing LV function and warrant consideration in clinical decision-making.

Keywords: Elective Percutaneous Coronary Intervention, Coronary Artery Disease, Left Ventricular Function, Left Ventricular Ejection Fraction, Left Ventricular Diastolic Dysfunction.

Introduction

Cardiovascular diseases are the leading cause of death worldwide, with coronary artery disease (CAD) being a significant contributor. Mortality rates related to CAD are expected to rise, particularly in developing countries.[1] Myocardial infarction (MI) can lead to myocardial necrosis, resulting in left ventricular (LV) dilatation and subsequent LV systolic dysfunction through cardiac remodelling. Treatment options for CAD include medical therapy, percutaneous coronary intervention (PCI), and coronary artery bypass graft (CABG). The goal of revascularization is to improve the function of viable myocardium. Early coronary re-canalization helps preserve viable myocardium, enhance global LV function, and improve survival. Studies have shown that surgical revascularization (CABG) or PCI can improve outcomes in patients with CAD and LV dysfunction. PCI, compared to CABG, is a less aggressive and less costly procedure that can be performed immediately after angiography, requires shorter hospitalization, and has fewer complications.[2] In CAD patients with preserved LV function and optimal medical therapy, PCI may not reduce cardiac death and MI but can decrease the need for additional procedures and the risk of angina.[3] Its impact on LV systolic or

diastolic function remains uncertain. PCI is increasingly utilized for revascularization in patients with ischemic heart disease (IHD). Previous studies have mainly focused on primary PCI, considering factors such as ejection fraction (EF), diastolic function, wall motion, and chamber sizes.[4] However, studies examining the effects of elective PCI have yielded inconsistent results. The timing of PCI relative to the MI event, baseline LVEF before PCI, and overall patient condition can influence the outcomes of PCI. Therefore, this study aims to investigate the impact of elective PCI on LV function at our cardiac centre.

Aim

The aim of this study is to evaluate the extent of improvement in left ventricular (LV) function following elective percutaneous coronary intervention (PCI) in patients with coronary artery disease (CAD).

Objectives

1. To assess the degree of improvement in LV function after PCI in patients with CAD.
2. To evaluate the progression of LV function improvement over time following the index event.

Evaluation of Left Ventricular Function

The assessment of left ventricular (LV) function is commonly performed using echocardiography, which is a widely used imaging technique. One of the key parameters used to evaluate LV function is the left ventricular ejection fraction (LVEF). Numerous studies have demonstrated that LVEF serves as a predictor of unfavourable outcomes following percutaneous coronary intervention (PCI) in patients with compromised LV function. [5] Various echocardiographic methods can be employed to measure LVEF, including 2D echocardiography, 3D echocardiography, and speckle-tracking echocardiography (STE). Among these techniques, STE has shown superior accuracy compared to traditional 2D echocardiography, particularly in patients with challenging acoustic windows[6]

In our study, we evaluated LV function using 2D echocardiography.

Systolic dysfunction was evaluated using the eyeballing method, which involved visual estimation of left ventricular function based on echocardiographic images. The assessment was performed by experienced cardiologists. This method, although subjective, is commonly used in clinical practice and has been validated in previous studies.[7]

Diastolic function will be assessed using Doppler echocardiography and Tissue Doppler Imaging (TDI). Measurements such as E, A, E/A ratio, E', A', deceleration time (DT), and E/E' will be obtained. Based on these measurements, patients will be further categorized into different grades of diastolic dysfunction, ranging from grade 1 to grade 4.[8]

Materials and Methods

Study Design

This study was conducted as an observational cohort study to assess the impact of elective percutaneous coronary intervention (PCI) on left ventricular (LV) function in patients with coronary artery disease (CAD).

The study took place at the Department of Cardiology in MDM Hospital, which is affiliated with Dr. S.N. Medical College in Jodhpur. The study was conducted over a period of 9 to 12 months or until the desired sample size and follow-up is achieved. The sample size has 104 subjects.

Study Procedures

Participant Recruitment: Patients with CAD who was scheduled to undergo elective PCI were recruited from the cardiology department. Informed consent was obtained from each participant. Prior to the PCI procedure, baseline data were collected, including demographic information, medical history, and baseline echocardiographic measurements. The PCI procedure was performed according to standard clinical practice guidelines by experienced interventional cardiologists.

Participants were scheduled for regular follow-up visits at the outpatient department. During these visits, clinical assessments were conducted, and any adverse events or complications related to the PCI procedure were recorded.

Echocardiographic evaluations were performed at baseline and at specific intervals (i.e. 3 month and at 6 month) during the follow-up period. Measurements of left ventricular ejection fraction (LVEF) and diastolic function was obtained using established echocardiographic techniques. The collected data was analysed using appropriate statistical methods. Changes in LVEF and diastolic function parameters were assessed, and the significance of any observed improvements in LV function following elective PCI will be determined.

This study has received ethical approval from the institutional ethical and scientific committee. All participants included had provide informed consent before their inclusion in the study. Confidentiality of patient information were strictly maintained throughout the study.

Study Population

Inclusion Criteria	Exclusion Criteria:
• Age between 18 and 80 years. • Diagnosis of coronary artery disease with left ventricular ejection fraction (LVEF) less than 40%.	• Coronary artery disease with LVEF equal to or greater than 40%. • Presence of arrhythmia. • Prior coronary artery bypass graft (CABG) surgery. • Electrocardiogram (ECG) evidence of left ventricular hypertrophy (LVH). • Chronic kidney disease (CKD). • Chronic liver disease (CLD). • History of valvular heart disease. • Cardiomyopathy. • Previous failed percutaneous coronary intervention (PCI). • Presence of pericardial effusion. • History of myocarditis or pericarditis. • Poor echocardiographic window. • Patients with poor cooperation.

The enrolled patients were divided into two groups based on their left ventricular (LV) systolic dysfunction:

Group 1: Patients with LV systolic dysfunction characterized by a left ventricular ejection fraction (LVEF) of less than 30%.

Group 2: Patients with LV systolic dysfunction characterized by an LVEF between 30% and 40%.

Results

Our study included a total of 104 participants, consisting of 75 males (72%) and 29 females (28%). The enrolled patients ranged in age from 35 to 79 years, with an average age of 57 years.

Table 1: Age group of population studied

Male/ Female Ratio	75/29	
Mean age	57 year	
Mean age	Male	58 year
	Female	57 year
Range	Male	35-79 years
	Female	38-72 years

Risk factors

The major contributory risk factor in our study was systemic hypertension, accounting for 47% of the cases. Diabetes mellitus was the second most prevalent risk factor, present in 40% of the cases, followed by cigarette smoking at 34%. Dyslipidaemia was found to be present in 34% of the cases as well. The majority of patients in our study (40.38%) experienced anterior wall myocardial infarction. The distribution of patients across different categories can be visualized in the accompanying pie chart.

Table 2: Risk factor of population studied

Risk factors	Diabetes mellitus	40(38.46%)
	Hypertension	49(47.11%)
	Dyslipidaemia	16(15.38%0
	Smoking	36(34.61%)
	Family history	7(6.73%)

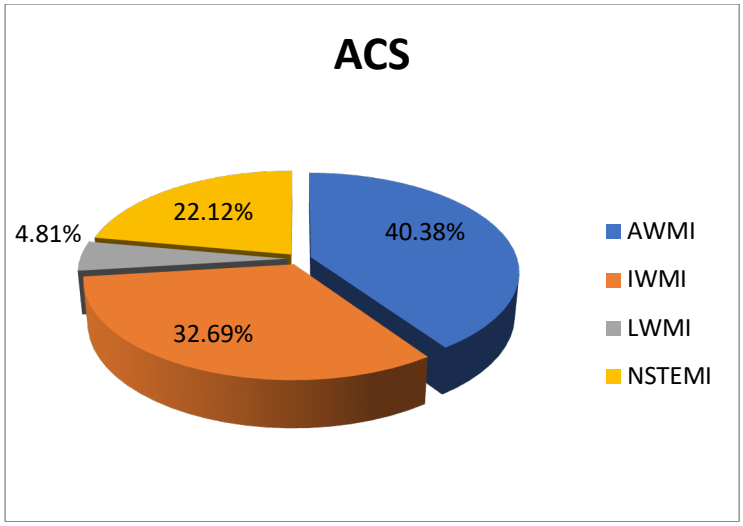

Figure 1: Pie chart shows the type of ACS event in study population. 40.38% had Anterior wall MI, 32.69% has inferior wall MI,22.12% has Lateral wall MI and 4.81% were classified as NSTEMI

In our study, the majority of percutaneous coronary interventions (PCI) were performed on the Left Anterior Descending artery (LAD), accounting for 44.23% of the cases. This was followed by interventions on the Right Coronary Artery (RCA) in 24.03% of the cases and the Left Circumflex artery (LCX) in 15.38% of the cases. A small percentage of cases involved interventions in multiple coronary arteries (multivessel PCI). (shown in table 3).

Table 3: vessel intervened during Elective PCI

PCI vessels	No. of patients	Percentage
LAD	46	44.23
LCX	16	15.38
RCA	25	24.04
LAD/LCX	7	6.73
LAD/RCA	1	0.96
LCX/LAD	3	2.88
LCX/OM	1	0.96
RAMUS/LAD	1	0.96
RCA/LCX	3	2.88
LM-LAD	1	0.96
Total	104	100.00

In our study, the enrolled patients were categorized into two groups based on their left ventricular (LV) systolic dysfunction. Group 1 consisted of patients with severe LV systolic dysfunction, characterized by a left ventricular ejection fraction (LVEF) of less than 30%. There were 53 patients in this group. Group 2 included patients with moderate LV systolic dysfunction, defined by an LVEF between 30% and 40%. A total of 51 patients were assigned to this group.

Table 4: group 1 (EF <30% ; group 2-EF-30-40%)

	No. of patients	Percentage
Group I	53	51%
Group II	51	49%
Total	104	100.00

Evaluation of Left ventricular systolic function

In the evaluation of left ventricular systolic function in our study, a significant percentage of patients (93.27%) demonstrated improvement following percutaneous coronary intervention (PCI). Specifically, out of the total 104 patients, 97 patients (93.27%) showed improvement in their left ventricular function at the end of the 6-month follow-up period. On the other hand, a smaller proportion of patients (6.73%) did not experience any improvement, and their left ventricular function remained the same throughout the 6-month duration.

Table 5; response to elective PCI

Response to PCI	No. of patients	Percentage
Response	97	93.27
No response	7	6.73
Total	104	100.00

In the overall cohort of patients, the baseline left ventricular ejection fraction (LVEF) was 30.7%. Following percutaneous coronary intervention (PCI), the LVEF showed significant improvement. At the 3-month follow-up, the mean LVEF increased to 37.4%.

Further improvement was observed at the 6-month follow-up, with the mean LVEF reaching 39.2%.

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Notably, the majority of the improvement occurred within the initial 3 months, with a 6.7% increase, compared to a smaller 1.8% increase in the subsequent 3 months.

The table 6 displays the mean left ventricular ejection fraction (LVEF) at three different time points: baseline, 3-month follow-up, and 6-month follow-up

Table 6- mean LVEF at baseline ,at 3 month and at 6 month in overall population

Follow up	Mean LVEF	SD
Baseline	30.7%	5.3
At 3 months	37.4%	6.3
At 6 months	39.2%	6.8

The trend of improvement in left ventricular ejection fraction (LVEF) can be observed through a line diagram (figure 2). The curve representing the change in LVEF from baseline to the 3-month mark shows a steeper slope compared to the curve from the 3-month to the 6-month follow-up. This suggests that the rate of improvement in LVEF was higher during the initial 3 months and relatively slower in the subsequent 3 months.

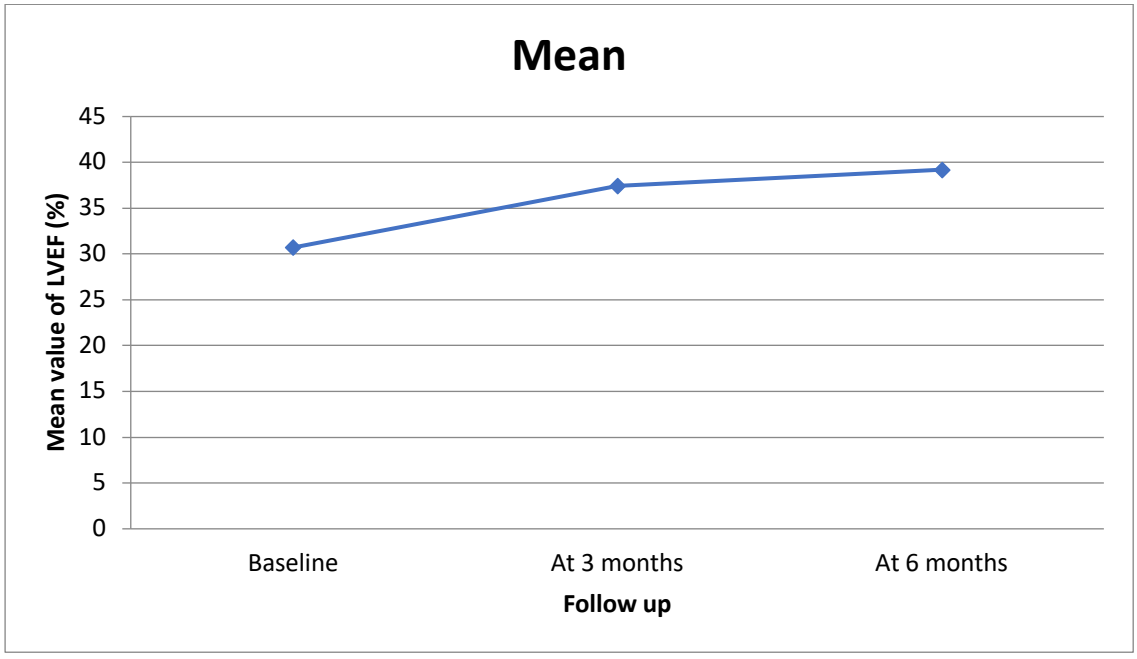

Figure 2:Trend of LVEF improvement

In Group 1, which consisted of patients with a left ventricular ejection fraction (LVEF) of less than 30%, the mean LVEF at baseline was 23.5%. Following percutaneous coronary intervention (PCI), the mean LVEF showed improvement at the 3-month follow-up, with an average of 30.5%. At the 6-month follow-up, the mean LVEF further increased to 32.16%.The majority of the improvement in LVEF within Group 1 occurred during the first 3 months, with a notable increase of 7%. In comparison, the subsequent 3 months saw a relatively smaller improvement of 1.66%. This indicates that the initial period after PCI had a more significant impact on the improvement of LVEF in patients with severe systolic dysfunction. Table shows LVEF at baseline, 3month and at 6 months in Group 1.

Table 7: mean LVEF at baseline ,at 3 month and at 6 month in group 1

Follow up	LVEF (%) (n=53)		
	Mean	SD	Range
Baseline	23.5	2.67	15-25
At 3 months	30.5	5.62	20-40
At 6 months	32.16	6.78	20-45

Trend of improvement in LVEF in group 1 pateints shown in figure 3

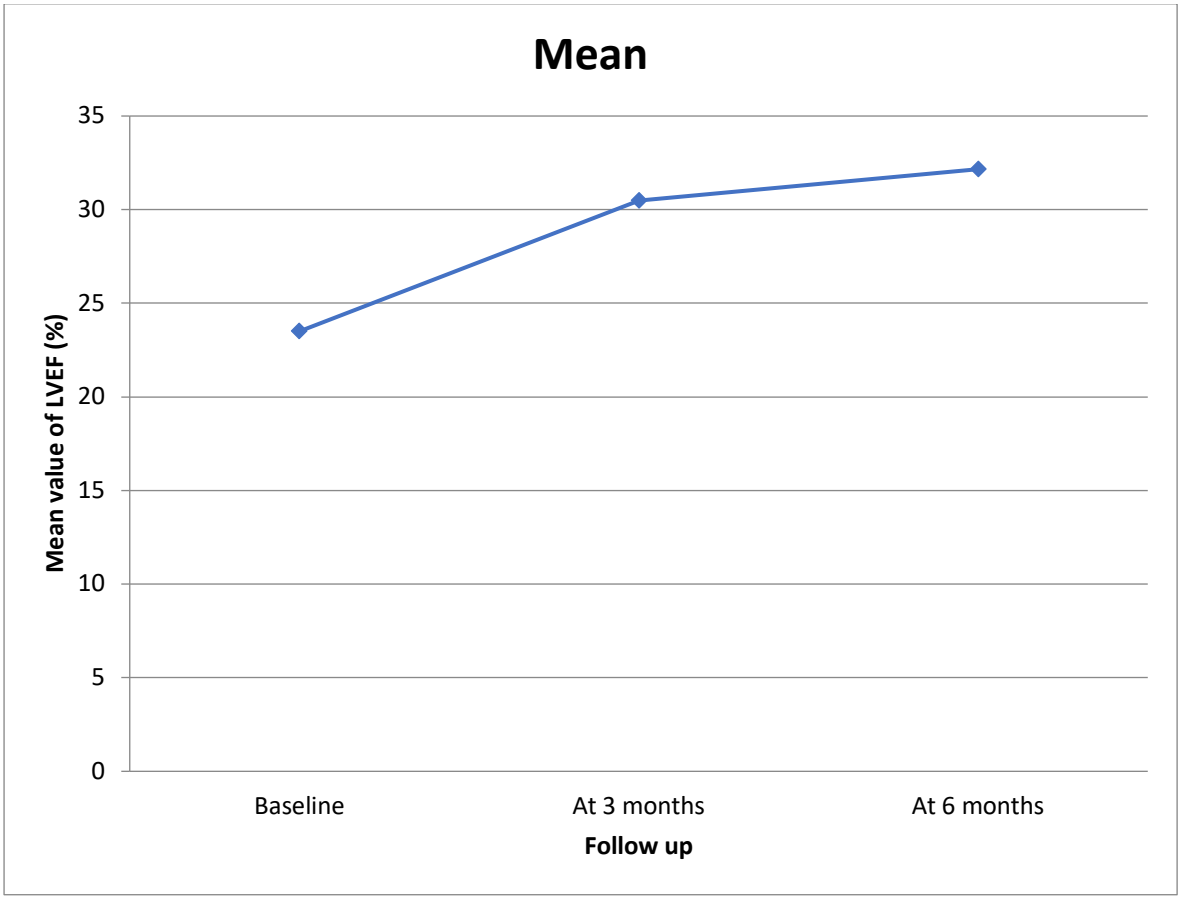

Figure 3: Mean

The trend of improvement in left ventricular ejection fraction (LVEF) in Group 2 patients can be observed by comparing the mean LVEF values at different time points. In this group, the baseline mean LVEF was 33.7%. Over the course of the study, there was a clear improvement in LVEF.

At the 3-month follow-up, the mean LVEF increased to 40.2%, indicating a significant improvement from baseline. This suggests that patients in Group 2 experienced a positive response to percutaneous coronary intervention (PCI) within the initial 3 months of the study. Continuing the follow-up to the 6-month mark, there was a further increase in the mean LVEF to 42.16%. This demonstrates a continued trend of improvement in LVEF in Group 2 patients, albeit at a slightly slower rate compared to the initial 3 months.

Overall, the data indicates a progressive enhancement in left ventricular systolic function among Group 2 patients, showing that PCI had a positive impact on improving LVEF in this cohort.

Table 8: Mean LVEF at baseline, at 3 month and at 6 months in Group 2

Follow up	LVEF (%) (n=74)		
	Mean LVEF	SD	Range
Baseline	33.71%	2.75	30-40
At 3 months	40.2%	4	30-40
At 6 months	42.16%	4.38	30-40

Trend of improvement in LVEF in group 2 patients is shown in figure 4

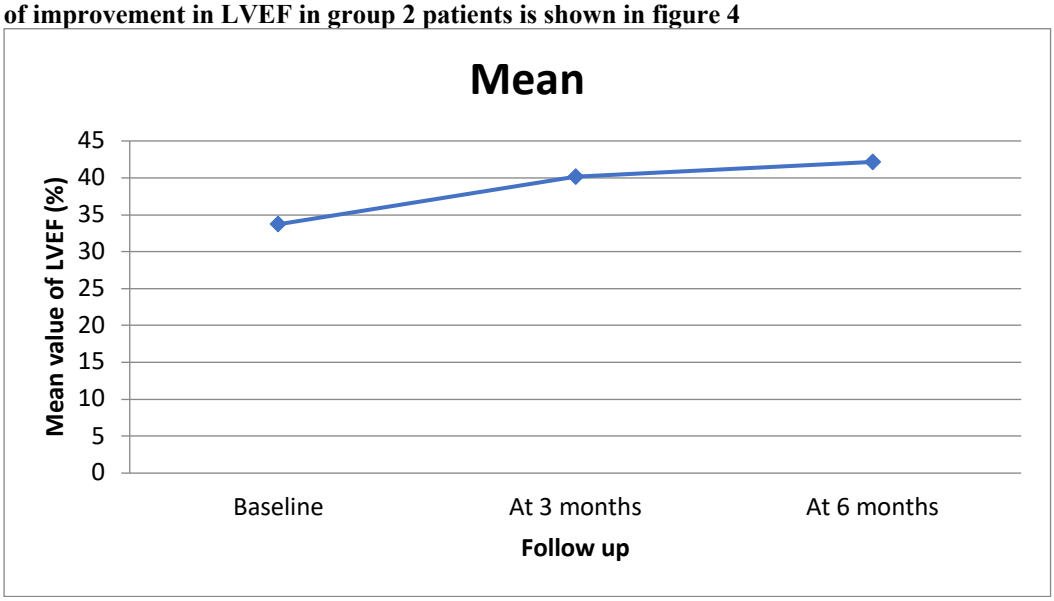

Figure 4: Mean

When comparing the improvement in left ventricular ejection fraction (LVEF) between Group 1 and Group 2, it is observed that Group 1 had a slightly higher improvement compared to Group 2. Group 1 showed an improvement of 8.66%, while Group 2 exhibited an improvement of 8.45%. Although there is a slight difference, it is important to note that this difference is statistically non-significant. Therefore, the improvement in LVEF between the two groups can be considered comparable in terms of statistical significance.

Table 9: comparison of improvement in group 1 and group 2

Baseline LVEF (%)	Mean difference from baseline and at 6 months.
Group 1	8.66%
Group 2	8.45%

Evaluation of Left ventricular diastolic dysfunction (LVDD)

The prevalence of LVDD is summarized in following bar diagrams. (figure 5)

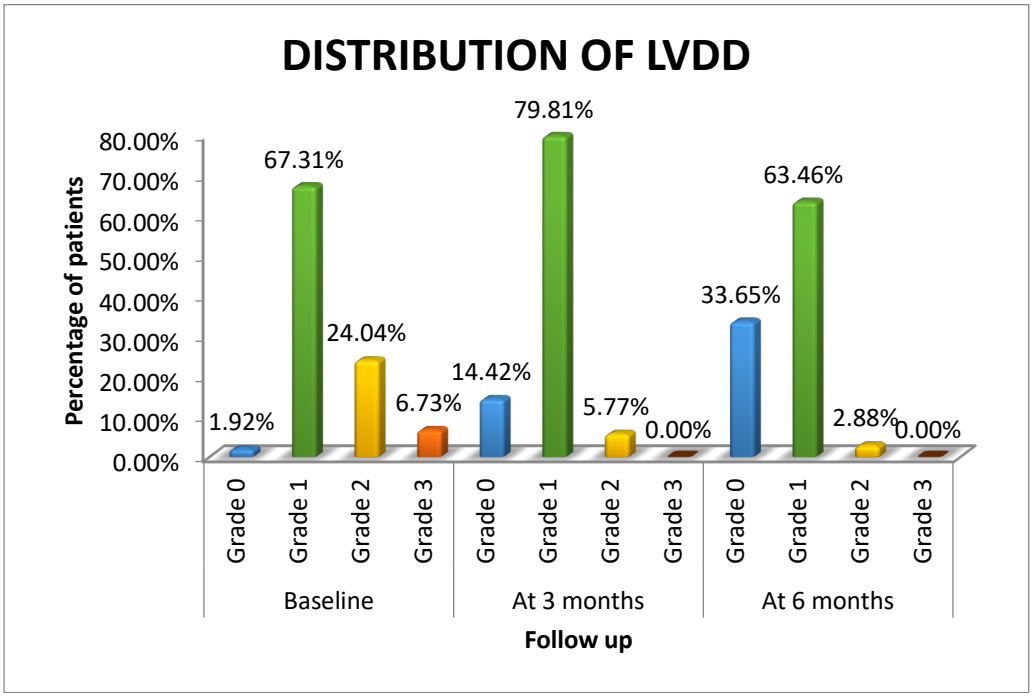

Figure 5: Distribution of LVDD

At baseline, the majority of patients (67.31%) were classified as grade 1 LVDD, while 24.04% were classified as grade 2, and only 6.73% were classified as grade 3. At the 3-month follow-up, there was a noticeable improvement in LVDD. Normal LVDD was present in 14.42% of the patients, and the majority (79.81%) were classified as grade 1, with only 5.77% remaining in grade 2. This increase in the incidence of grade 1 LVDD at 3 months compared to baseline is primarily due to patients transitioning from grade 2 to grade 1, indicating an improvement in diastolic function.

By the 6-month follow-up, there was further improvement in LVDD. A total of 33.65% of patients had normal LVDD, while 63.46% were classified as grade 1, and a small proportion (2.88%) remained in grade 2. These results demonstrate a significant improvement in left ventricular diastolic dysfunction following percutaneous coronary intervention (PCI). The prevalence of normal LVDD increased over time, along with a reduction in the proportion of patients with more severe grades of LVDD.

Role of timing of intervention from the index event

In our study, patients underwent elective percutaneous coronary intervention (PCI) within a specific timeframe following the index event. The timing of intervention ranged from day 2 to day 10, with a median of day 4. The findings from the scatter diagram (figure 6) indicate a relationship between the timing of intervention and the improvement in left ventricular (LV) function. Specifically, the diagram suggests that the earlier the intervention occurred from the index event, the greater the observed improvement in LV function. This observation emphasizes the potential benefits of early intervention in patients with cardiac conditions.

The data suggests that prompt elective PCI within the specified timeframe may contribute to a more significant enhancement of LV function. These findings highlight the importance of considering the timing of intervention as a factor in optimizing patient outcomes and improving LV function following the index event.

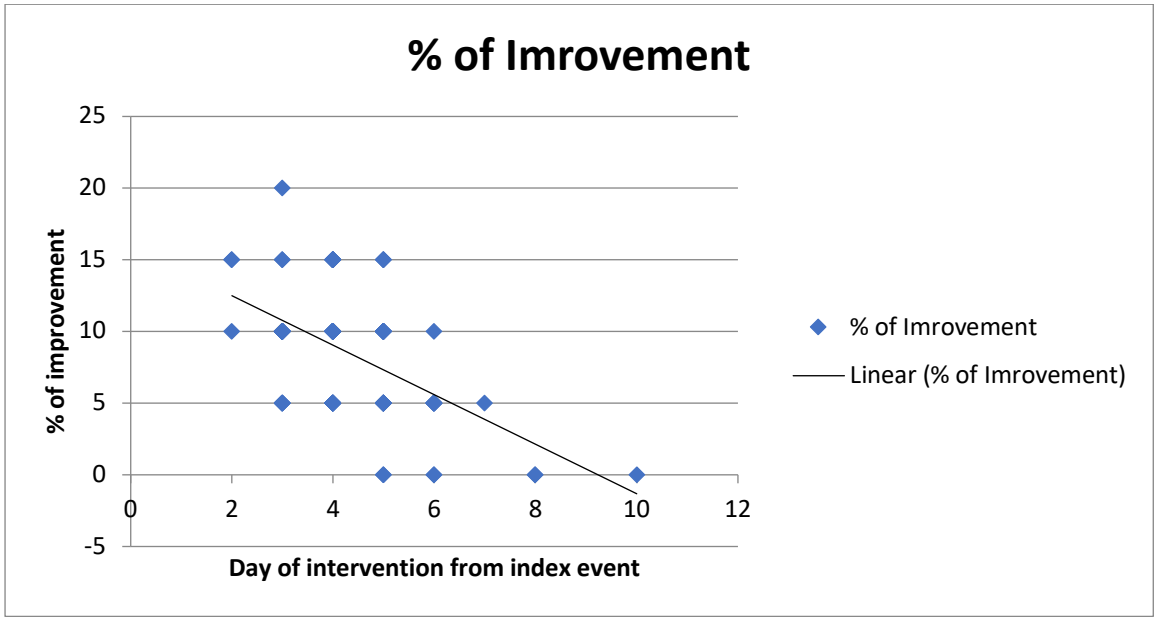

Figure 6: Percentage of improvement

Discussion

The findings of this study provide valuable insights into the assessment of left ventricular (LV) function following elective percutaneous coronary intervention (PCI) in patients with coronary artery disease (CAD) with compromised LV function. The results demonstrate significant improvements in LV systolic and diastolic function after PCI, highlighting the effectiveness of this intervention in enhancing cardiac performance.

The study population consisted of 104 patients with CAD with compromised LV function, with a majority of males and an average age of 57 years. Systemic hypertension, diabetes mellitus, and smoking were the major risk factors observed in this cohort, emphasizing the importance of addressing these factors in CAD management.

In terms of PCI vessels, the Left Anterior Descending artery (LAD) was the most frequently intervened artery, followed by the Right Coronary Artery (RCA) and the Left Circumflex artery (LCX). These findings align with the distribution patterns observed in previous studies.[9]

The evaluation of LV systolic function revealed a substantial improvement in LVEF following PCI. The majority of patients showed improvement in LV function, with only a small proportion not experiencing any improvement. The mean LVEF increased from baseline (30.7%) to 3 months (37.4%) and 6 months (39.2%). Notably, the most significant improvement occurred within the initial 3 months, highlighting the importance of early intervention in maximizing the benefit of PCI.

Group 1 patients with severe LV systolic dysfunction exhibited a remarkable increase in LVEF. The mean LVEF improved from 23.5% at baseline to 32.16% at the 6-month follow-up. The majority of improvement occurred within the first 3 months, emphasizing the early benefits of PCI in this patient subgroup.

In Group 2 patients with moderate LV systolic dysfunction, there was a consistent improvement in LVEF over the 6-month period. The mean LVEF increased from 33.71% at baseline to 42.16% at the 6-month follow-up. This suggests that PCI has a positive impact on improving LV function in patients with moderate systolic dysfunction, with progressive enhancement observed over time.

Comparing the improvement in LVEF between Group 1 and Group 2, both groups showed similar improvements, indicating that the benefits of PCI were comparable regardless of the severity of LV systolic dysfunction. These results emphasize the potential of PCI in improving LV function, even in patients with severe systolic dysfunction.

Furthermore, the study evaluated LV diastolic dysfunction (LVDD) and demonstrated a significant improvement over time. The prevalence of normal LVDD increased, while the proportion of patients with more severe grades of LVDD decreased. This indicates that PCI not only improves systolic function but also positively influences diastolic function, contributing to overall LV performance enhancement.

The timing of intervention from the index event was found to be associated with the degree of LV function improvement. Patients who underwent early elective PCI demonstrated greater improvements in LV function compared to those with delayed intervention. These findings highlight the importance of prompt revascularization in optimizing patient outcomes and improving LV function following the index event.The literature surrounding the assessment of left ventricular (LV) function after elective percutaneous coronary intervention (PCI) in patients with coronary artery disease (CAD) and compromised LV function provides valuable insights into the effectiveness of this intervention and its impact on cardiac outcomes.

Numerous studies have highlighted the role of revascularization, including PCI, in improving LV function in patients with CAD. In a study by St John Sutton et al. (2000), patients with LV dysfunction and viable myocardium who underwent revascularization, either through PCI or coronary artery bypass grafting (CABG), showed significant improvements in LV ejection fraction (LVEF) compared to those receiving medical therapy alone. These findings support the notion that revascularization procedures, such as PCI, can preserve viable myocardium and enhance LV function.[10]

The timing of PCI in relation to the index event, such as myocardial infarction (MI), has been a topic of interest in the literature. Early revascularization has been shown to have beneficial effects on LV function. A study by Bolognese et al. (2002) demonstrated that patients who underwent primary PCI within 12 hours of symptom onset had significantly higher LVEF and lower rates of adverse cardiac events compared to those with delayed intervention. These findings emphasize the importance of prompt revascularization in optimizing LV function and improving outcomes.[11]

The impact of PCI on LV diastolic function has also been investigated. A study by Owan et al. (2006) evaluated changes in LV diastolic function after revascularization in patients with ischemic cardiomyopathy. The results showed significant improvements in LV diastolic function parameters, including E/A ratio and deceleration time, following PCI.[12] This suggests that revascularization procedures, such as PCI, not only improve LV systolic function but also positively influence diastolic function, contributing to overall LV performance enhancement.

Conclusion

our study demonstrates that elective percutaneous coronary intervention (PCI) in patients with coronary artery disease (CAD) and compromised left ventricular (LV) function leads to significant improvements in LV function. The majority of patients showed a positive response to PCI, with an increase in left ventricular ejection fraction (LVEF) and a reduction in left ventricular diastolic dysfunction (LVDD) grades. These findings are consistent with previous studies and highlight the benefits of timely intervention in optimizing LV function and improving patient outcomes

Limitations of Our Study

1. Small cohort: Our study had a limited number of participants, which may affect the generalizability of our findings. Further research with larger cohorts and longer follow-up periods is necessary to validate these

findings and provide more comprehensive insights into the role of elective PCI in patients with CAD and compromised LV function.
2. Single centre: Conducting the study at a single centre may limit the applicability of the results to other healthcare settings.
3. Selection bias: There is a possibility that our sample may not represent the broader population due to the specific characteristics of patients who underwent elective PCI at our centre.
4. Observer bias in evaluating LVEF: Subjective interpretation of LVEF measurements may introduce variability, and the expertise of different observers could impact the results.
5. Viability assessment not done: We did not assess the viability of the myocardium, which may influence the outcomes of elective PCI and limit the interpretation of our results.

These limitations should be considered when interpreting our findings and generalizing them to a larger population.

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