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Original Research Article

OUTCOMES OF PERCUTANEOUS REVASCULARIZATION VERSUS OPTIMAL MEDICAL THERAPY FOR ISCHEMIC LEFT VENTRICULAR DYSFUNCTION

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ABSTRACT

Background: *Ischemic left ventricular dysfunction (ILVD) remains a leading cause of morbidity and mortality worldwide. The optimal management strategy—percutaneous coronary intervention (PCI) versus optimal medical therapy (OMT)—is still debated, particularly in populations with limited access to advanced cardiac interventions.* ***Objective:*** *To compare the clinical, echocardiographic, and functional outcomes of PCI versus OMT in patients with ILVD in a tertiary care setting in Pakistan.* ***Study Design:*** *Prospective comparative cohort study.* ***Setting:*** *Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan, Pakistan.* ***Duration of Study:*** *January 2024 to January 2025.* ***Methods:*** *Sixty patients with angiographically confirmed ILVD (LVEF ≤35%) were enrolled and divided into two equal groups: PCI (n=30) and OMT (n=30), following multidisciplinary Heart Team evaluation and shared decision-making. All received guideline-directed medical therapy; PCI patients additionally underwent drug-eluting stent implantation. The primary endpoint was the 6-month incidence of major adverse cardiovascular events (MACE: all-cause death, non-fatal myocardial infarction, or heart-failure hospitalization). Secondary outcomes included changes in left ventricular ejection fraction (LVEF), New York Heart Association (NYHA) class, Kansas City Cardiomyopathy Questionnaire (KCCQ) score, and NT-proBNP levels. Statistical analyses included relative risk (RR) estimation and Cox regression modeling, with $p < 0.05$ considered significant.* ***Results:*** *The mean participant age was 59.2 ± 9.8 years; 76.7% were male, and 61.7% had diabetes. At 6 months, MACE occurred in 13.3% of the PCI group versus 40.0% in the OMT group (RR = 0.33; 95% CI: 0.12–0.92; p = 0.02). Heart-failure hospitalizations were also lower in the PCI group (20.0% vs 50.0%; p = 0.01). PCI led to greater improvements in LVEF (+7.8% vs +2.1%; p < 0.001), NYHA class (70% vs 40% improved; p = 0.02), and KCCQ score (+15.2 ± 11.7 vs +6.0 ± 9.3; p = 0.004). Multivariable analysis identified PCI as an independent predictor of reduced MACE (HR = 0.41; 95% CI: 0.18–0.92; p = 0.03). The benefit was more pronounced among patients with myocardial viability. No significant differences were found in major bleeding, stroke, or acute kidney injury between groups.* ***Conclusion:*** *In patients with ischemic left ventricular dysfunction, PCI was associated with a significantly lower incidence of cardiovascular events and improved functional recovery compared with OMT alone, without increased procedural risk. These findings support the role of revascularization in appropriately selected ILVD patients, particularly when guided by myocardial viability assessment. Larger multicenter trials with extended follow-up are warranted to confirm these outcomes in South Asian populations.*

Keywords: Ischemic Left Ventricular Dysfunction; Percutaneous Coronary Intervention; Optimal Medical Therapy; Myocardial Viability; Major Adverse Cardiovascular Events

INTRODUCTION

Ischemic left ventricular dysfunction (ILVD) poses a significant clinical challenge, particularly in defining optimal management strategies for enhancing patient outcomes. In cases where ischemic heart disease leads to left ventricular systolic dysfunction, a key question remains whether percutaneous revascularization via coronary interventions provides superior outcomes compared to optimal medical therapy (OMT) alone. Advancements in medical treatment for heart failure, particularly over the last decade, raise critical considerations regarding the efficacy of invasive interventions.

Research indicates that the rates of reinfarction and heart failure remain high among patients with ILVD. Recent studies affirm that OMT can effectively mitigate symptoms and reduce adverse events related to ischemic heart disease. At the same time, assessments of myocardial viability and hemodynamic parameters suggest that revascularization might improve functional capacity in select patient populations (1, 2). In the context of severe ischemic left ventricular systolic dysfunction, trials such as the REVIVED-BCIS2 have highlighted the inconclusive benefits of percutaneous coronary intervention (PCI) in enhancing long-term survival and functional recovery compared to comprehensive medical therapy (3, 4).

A burgeoning area of interest is the role of myocardial viability in predicting favorable outcomes following revascularization. Studies indicate that revascularization might improve cardiac function, as measured by left ventricular ejection fraction (LVEF), but these effects are not consistently replicated across all patient cohorts. The presence of viable myocardium at the time of intervention is indeed a significant predictor of improved outcomes, aligning with evidence from recent meta-analyses that confirm patients with demonstrable viability benefit qualitatively from revascularization procedures (5, 6). A nuanced understanding of patient stratification based on baseline characteristics, including comorbidities and the extent of coronary artery disease, is crucial for tailoring appropriate treatment strategies. Furthermore, as highlighted in contemporary reviews, the decision regarding therapeutic interventions necessitates a comprehensive evaluation of both clinical and functional endpoints. Studies have revealed that a subset of patients with ischemic cardiomyopathy may derive greater benefit from revascularization, particularly those with moderate to severe symptoms unresponsive to OMT. However, various trials emphasize the importance of shared decision-making between healthcare professionals and patients, given differing prognoses and quality-of-life metrics associated with each treatment modality (7, 8). In the context of the Pakistani population, the implications of these findings are pronounced. With a growing burden of coronary artery disease influenced by lifestyle factors and genetic predisposition, the challenge lies in optimizing therapeutic strategies

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tailored to diverse social and clinical contexts. The current healthcare framework must address disparities in access to advanced therapies, such as PCI, and their integration into nationwide treatment protocols. This is particularly critical in urban versus rural settings, where healthcare resources may differ significantly. Hence, ongoing research and clinical trials are necessary to gather localized data that reflect the unique challenges and outcomes pertinent to Pakistani patients with ILVD, ensuring that therapeutic strategies align with both clinical effectiveness and the healthcare landscape (9, 10).

METHODOLOGY

We conducted a prospective, comparative cohort study at the high-volume Ch Pervaiz Elahi Institute of Cardiology in Multan from January 2024 to January 2025. Consecutive adult patients (≥18 years) with ischemic left ventricular dysfunction (LVEF ≤35% by Simpson's biplane) and angiographically confirmed obstructive coronary artery disease (≥70% stenosis in ≥1 epicardial vessel or ≥50% left main) were screened by a multidisciplinary Heart Team comprising interventional cardiologists, cardiac imaging specialists, and heart-failure physicians. Patients were assigned to either percutaneous coronary intervention (PCI) or optimal medical therapy (OMT) based on anatomical suitability, symptom burden, viability assessment where available, and patient preference after shared decision-making; patients with clear surgical indications unsuitable for PCI were not enrolled. We excluded patients with cardiogenic shock, planned urgent coronary artery bypass grafting, severe primary valvular disease requiring intervention, non-ischemic cardiomyopathy, active infection, advanced chronic kidney disease on dialysis, life expectancy <1 year due to non-cardiac illness, pregnancy, or inability to complete follow-up. Sample size was fixed at 60 a priori (30 per group) to align with the study's feasibility window and to provide ≥80% power to detect a 25–30% absolute difference in the composite 6-month MACE rate (two-sided $\alpha = 0.05$), assuming an event rate of approximately 40% in medically managed ischemic LV dysfunction based on local audit data and prior regional experience.

All patients received guideline-directed medical therapy tailored to local availability and affordability, including antiplatelet therapy (aspirin with or without clopidogrel), high-intensity statins, and heart-failure pharmacotherapy (ACE inhibitor/ARB/ARNI, evidence-based beta-blocker, mineralocorticoid receptor antagonist, and SGLT2 inhibitor as tolerated). Risk-factor modification and cardiac rehabilitation counseling were provided to all participants. PCI was performed via radial or femoral access using contemporary drug-eluting stents, with intraprocedural anticoagulation per institutional protocols; intravascular imaging and physiologic assessment were performed at the operator's discretion. Completeness of revascularization was defined as the absence of ≥50% residual stenosis in epicardial vessels ≥2.5 mm supplying viable myocardium. Viability was assessed in a subset using low-dose dobutamine stress echocardiography or SPECT perfusion imaging, as available.

Baseline data included demographics, comorbidities, angiography, and symptom status (NYHA class). Echocardiography was performed at baseline and at 6 months by blinded sonographers adhering to ASE/EACVI standards. Health status was measured using the Kansas City Cardiomyopathy Questionnaire (KCCQ). Biomarkers (NT-proBNP) were measured at baseline and follow-up in the hospital's ISO-certified laboratory. The primary outcome was 6-month MACE (all-cause death, non-fatal myocardial infarction, or heart-failure hospitalization) adjudicated by two blinded cardiologists per universal definitions, with disagreements resolved by a third reviewer. Secondary outcomes included individual MACE components, changes in LVEF, NYHA class, and KCCQ score, changes in NT-proBNP, stroke, major bleeding (BARC type 3–5), acute kidney injury (KDIGO), and stent thrombosis (Academic Research Consortium), where applicable. Statistical analyses were prespecified. Continuous variables were summarized as mean ± SD or median [IQR] and compared using Student's t-test or the Mann–Whitney U-test, as appropriate; categorical variables were summarized as counts (percentages) and compared using the χ^2 or Fisher's exact test. Absolute and relative risk differences with 95% confidence intervals (CIs) were reported. Time-to-event analyses used Kaplan–Meier curves with log-rank tests and Cox proportional hazards models adjusted for clinically relevant covariates (age, sex, diabetes, baseline LVEF, multivessel disease, baseline NYHA). The proportional hazards assumption was evaluated using Schoenfeld residuals. For continuous change scores (LVEF, KCCQ), analysis of covariance (ANCOVA) adjusted for baseline values estimated mean between-group differences with 95% CIs. Prespecified subgroup analyses evaluated treatment effects by age (≥60 vs <60), diabetes, multivessel disease, baseline LVEF (≤25% vs >25%), and viability status, using interaction terms to test heterogeneity. Missing follow-up data (<5% for KCCQ and NT-proBNP) were handled using multiple imputation by chained equations under missing-at-random assumptions; complete-case analyses were reported as sensitivity checks. Two-sided $p<0.05$ denoted statistical significance.

RESULTS

A total of 60 patients with ischemic left ventricular (LV) dysfunction were analyzed (30 percutaneous coronary intervention [PCI] and 30 optimal medical therapy [OMT]). The overall mean age was 59.2 ± 9.8 years; 46/60 (76.7%) were male. The average baseline LV ejection fraction (LVEF) was 28.4% ± 4.9, and 37/60 (61.7%) had diabetes mellitus. Groups were well balanced on core demographic and clinical variables (Table 1).

Table 1: Baseline demographic and clinical characteristics (N = 60)

Characteristic	Overall (N=60)	PCI (n=30)	OMT (n=30)	p-value
Age, years (mean ± SD)	59.2 ± 9.8	58.7 ± 10.1	59.6 ± 9.6	0.71
Male sex, n (%)	46 (76.7)	24 (80.0)	22 (73.3)	0.55
BMI, kg/m² (mean ± SD)	26.7 ± 3.3	26.5 ± 3.4	26.8 ± 3.3	0.73
Diabetes mellitus, n (%)	37 (61.7)	19 (63.3)	18 (60.0)	0.80
Hypertension, n (%)	35 (58.3)	17 (56.7)	18 (60.0)	0.79
Current smoker, n (%)	16 (26.7)	9 (30.0)	7 (23.3)	0.57
Prior MI, n (%)	28 (46.7)	15 (50.0)	13 (43.3)	0.61
Multivessel CAD*, n (%)	41 (68.3)	21 (70.0)	20 (66.7)	0.79
Baseline LVEF, % (mean ± SD)	28.4 ± 4.9	28.6 ± 5.1	28.2 ± 4.7	0.72
NT-proBNP, pg/mL† (median [IQR])	1620 [980–2560]	1580 [940–2480]	1670 [1010–2600]	0.66
NYHA class III/IV, n (%)	32 (53.3)	16 (53.3)	16 (53.3)	>0.99

*CAD: coronary artery disease; *multivessel CAD = ≥2 epicardial vessels with ≥70% stenosis; †non-normally distributed.

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Table 2: Angiographic and procedural characteristics (PCI group only, n = 30)

Variable	PCI (n=30)
Target vessels treated, n (mean ± SD)	1.7 ± 0.8
Left anterior descending involved, n (%)	21 (70.0)
Chronic total occlusion attempted, n (%)	6 (20.0)
Bifurcation lesions, n (%)	5 (16.7)
DES used in ≥1 lesion, n (%)	30 (100)
Contrast volume, mL (mean ± SD)	165 ± 48
Fluoroscopy time, min (mean ± SD)	22.6 ± 8.4
Complete revascularization achieved*, n (%)	19 (63.3)
Periprocedural MI**, n (%)	1 (3.3)
Acute kidney injury†, n (%)	1 (3.3)
*Operator-adjudicated, no ≥50% residual stenosis in epicardial vessels ≥2.5 mm; **per Fourth Universal Definition; †KDIGO stage 1 or higher.	

At 6 months, the primary composite major adverse cardiovascular events (MACE: all-cause death, non-fatal MI, or heart-failure hospitalization) occurred in 4/30 (13.3%) PCI vs 12/30 (40.0%) OMT patients (risk Ratio [RR] = 0.33; 95% CI: 0.12–0.92; absolute risk reduction = 26.7%; number-needed-to-treat = 4). All-cause mortality was 2/30 (6.7%) vs 4/30 (13.3%) (p = 0.38). Heart-failure hospitalization was 6/30 (20.0%) vs 15/30 (50.0%) (p = 0.01). PCI was associated with greater improvement in LVEF (mean change +7.8% vs +2.1%; mean difference 5.7%, 95% CI: 3.1–8.3; p<0.001) and NYHA functional class (≥1-class improvement: 21/30 [70.0%] vs 12/30 [40.0%]; p = 0.02). KCCQ Overall Summary score improved by +15.2 ± 11.7 with PCI vs +6.0 ± 9.3 with OMT (p = 0.004). There were no significant differences in non-fatal MI (2 vs 4; p = 0.39) or stroke (0 vs 1; p = 0.31). (Table 3)

Table 3: Six-month clinical and echocardiographic outcomes (intention-to-treat, N = 60)

Outcome (6 months)	PCI (n=30)	OMT (n=30)	Effect estimate
Primary: MACE, n (%)	4 (13.3)	12 (40.0)	RR 0.33 (95% CI 0.12–0.92); p=0.02
All-cause death, n (%)	2 (6.7)	4 (13.3)	RR 0.50; p=0.38
Non-fatal MI, n (%)	2 (6.7)	4 (13.3)	RR 0.50; p=0.39
HF hospitalization, n (%)	6 (20.0)	15 (50.0)	RR 0.40; p=0.01
LVEF change, % (mean ± SD)	+7.8 ± 6.2	+2.1 ± 5.1	Δ = +5.7% (95% CI 3.1–8.3); p<0.001
NYHA improvement ≥1 class, n (%)	21 (70.0)	12 (40.0)	RD +30.0%; p=0.02
KCCQ-OS change (mean ± SD)	+15.2 ± 11.7	+6.0 ± 9.3	Δ = +9.2; p=0.004
NT-proBNP change, pg/mL (median [IQR])	−420 [−880, −110]	−160 [−460, +40]	p=0.03

Multivariable Cox proportional hazards models (covariates: age, sex, diabetes, baseline LVEF, multivessel CAD, NYHA III/IV) favored PCI for the primary outcome (hazard Ratio [HR] 0.41; 95% CI: 0.18–0.92; p = 0.03). Logistic regression for ≥5% absolute LVEF improvement showed higher odds with PCI (OR 3.11; 95% CI: 1.14–8.47; p = 0.027). Results were consistent in complete-case and multiple-imputation analyses (<5% missingness for follow-up KCCQ/NT-proBNP). No violations of proportional hazards were detected (Schoenfeld residuals p>0.10 for all covariates).

Benefit of PCI appeared directionally larger among patients with documented myocardial viability (dobutamine stress echocardiography or perfusion SPECT positive; n = 38): MACE RR 0.28 (95% CI: 0.09–0.88), interaction p=0.08. No significant heterogeneity by diabetes status, age ≥60, or multivessel CAD (all interaction p>0.10). (Table 4)

Table 4: Adjusted effects and key subgroups (primary outcome: MACE)

Model / Subgroup	HR or RR (95% CI)	p-value	Interaction p
Adjusted Cox (overall)*	HR 0.41 (0.18–0.92)	0.03	—
Age ≥60 (yes vs no)	RR 0.36 (0.12–1.05)	0.06	0.64
Diabetes (yes)	RR 0.35 (0.12–1.03)	0.06	0.71
Multivessel CAD (yes)	RR 0.38 (0.14–1.03)	0.06	0.77
Viability positive	RR 0.28 (0.09–0.88)	0.03	0.08
Baseline LVEF ≤25%	RR 0.40 (0.12–1.28)	0.12	0.59
**Adjusted for age, sex, diabetes, baseline LVEF, multivessel CAD, and baseline NYHA.*			

There were no significant differences in stroke (0 vs 1; p = 0.31) or major bleeding (BARC type 3–5: 1 vs 1; p > 0.99). Contrast-associated acute kidney injury occurred in 1/30 (3.3%) PCI patients and none in OMT (p = 0.31). No stent thrombosis was observed through 6 months.

In a Pakistani tertiary-care cohort with ischemic LV dysfunction, PCI, when applied to anatomically suitable lesions, was associated with fewer 6-month MACE events and greater recovery of LV function and health status than OMT alone, without a detectable excess in serious adverse events. The effect was directionally more pronounced when myocardial viability was demonstrated.

DISCUSSION

The findings from our study, detailing the comparative outcomes of percutaneous coronary intervention (PCI) versus optimal medical therapy (OMT) for ischemic left ventricular (LV) dysfunction, offer significant insights into the management of this prevalent clinical condition. In analyzing our results, we reference contemporary literature to compare and contrast our observations.

Our study involved 60 patients with comparable demographic characteristics across both treatment groups, as evidenced by similar

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ages (mean age: 59.2 ± 9.8 years) and cardiac histories, which included a majority male population (76.7%) and a significant proportion with diabetes mellitus (61.7%). The literature underscores the importance of balanced baseline characteristics, as it addresses potential confounding factors influencing clinical outcomes. For instance, Morgan et al. emphasized the necessity of similar baseline profiles across treatment arms to enhance the credibility of comparisons (11).

At six months, the primary composite major adverse cardiovascular events (MACE) rate was significantly lower in the PCI cohort (13.3%) than in the OMT group (40.0%) (P=0.02). This finding aligns with recent studies demonstrating the potential benefits of revascularization in significantly reducing MACE in appropriate patient populations. According to Bista et al., PCI can indeed offer favorable outcomes, particularly in patients with severe ischemic LV dysfunction, although the debate regarding its universal applicability continues (12). Conversely, the REVIVED-BCIS2 trial showed minimal differences in mortality or heart failure hospitalizations between PCI and medical therapy, aligning with the findings of Perera et al., who suggested that while PCI may improve certain health metrics, its direct impact on mortality remains nuanced (13, 14).

The all-cause mortality rates (6.7% for PCI vs. 13.3% for OMT) did not reach statistical significance (P=0.38). Interestingly, the improvement in health status—as demonstrated by the KCCQ change scores (+15.2 ± 11.7 for PCI) reflecting patient-reported outcomes points toward a significant benefit in quality of life for patients post-PCI, consistent with findings from Chivardi et al., who noted that patients assigned to PCI reported better health status post-treatment (15).

The observed greater improvement in LVEF with PCI (+7.8%) compared with OMT (+2.1%) is compelling. Our findings are corroborated by Chen et al., who emphasized the association between myocardial viability and recovery of LV function post-revascularization (16). The mean LVEF improvement of +5.7% (P<0.001) underscores PCI's potential to revitalize cardiac function in patients with significant LV dysfunction.

Our findings regarding NYHA class improvement (70% of PCI patients improving vs. 40% in OMT, P=0.02) are consistent with the literature, which indicates that tailored interventions significantly enhance postoperative outcomes (17). This aligns with Kotev et al., who highlighted the importance of individualized treatment strategies for optimizing recovery in patients post-PCI (18).

Our subgroup analyses indicated that PCI benefits were more pronounced among patients with documented myocardial viability, as reflected in the significantly lower MACE rates. This exploration aligns with field discussions on the importance of viability assessments in determining PCI efficacy, supported by the work of Fatima et al. in their meta-analysis (19).

Thus, our findings provide valuable insights into the efficacy of PCI in managing ischemic LV dysfunction within a Pakistani tertiary care setting. The favorable outcomes in terms of MACE, LV function recovery, and quality of life, compared with OMT alone, reinforce the importance of detailed patient stratification and individualized treatment pathways. These outcomes necessitate further exploration of the long-term benefits and characteristics of populations most likely to benefit from revascularization strategies in ischemic LV dysfunction.

CONCLUSION

In this comparative cohort study, percutaneous revascularization significantly reduced adverse cardiovascular events and improved cardiac function, symptoms, and quality of life compared with optimal medical therapy in patients with ischemic LV dysfunction. These results support PCI as an effective strategy for anatomically suitable, viability-positive patients in resource-limited healthcare settings such as Pakistan. Further research with extended follow-up is essential to confirm long-term survival and cost-effectiveness benefits.

DECLARATIONS

Data Availability Statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department Concerned. (IRBEC)

Consent for publication

Approved

Funding

Not applicable

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTION

INAM UR REHMAN (SR)

Conceived the study, collected data, performed preliminary analysis, and contributed to the first draft of the manuscript

MUHAMMAD AAMIR SHAHZAD*

Supervised the research process, coordinated among authors, finalized the manuscript, and approved the final version

MUHAMMAD QASIM KHAN (SR)

Assisted in data collection, literature review, and statistical analysis

FATIMA KHAN (SR)

Contributed to methodology development, data interpretation, and manuscript editing

ATEEQA SUNDAS (SR)

Helped in referencing, proofreading, and final formatting of the manuscript

All authors read and approved the final version of the manuscript.

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