

Original Research Article

Outcome analysis in patients with multi vessel coronary artery disease and left ventricular ejection fraction after percutaneous coronary intervention: single center experience

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ABSTRACT

Background: The present study evaluated the changes in baseline left ventricular function and clinical symptoms in multi-vessel coronary artery disease patients after multi-vessel percutaneous coronary intervention.

Methods: This was a prospective, observational study conducted at Medical Super-speciality Hospital, Kolkata, India, between August 2017 and August 2019. The study included 48 patients who were diagnosed with ≥ 2 coronary artery stenosis of $\geq 50\%$ in native coronary arteries with left ventricular ejection fraction (LVEF) $< 40\%$. Echocardiography was performed before and after 3 months of the procedure to observe LVEF. Canadian Cardiovascular Society (CCS) score was calculated before and after 3 months after PCI.

Results: Mean age of the patients was 61.89 ± 9.96 years and 89.6% patients were male. Mean LVEF before and after angioplasty was $34.9 \pm 4.95\%$ and $42.06 \pm 8.78\%$, respectively ($p=0.001$). CCS score before and after angioplasty was 2.89 and 1.83, respectively ($p=0.001$).

Conclusions: The results displayed significant improvement in clinical symptoms as well as LVEF after PCI in patients with multi-vessel disease with LVEF $< 40\%$. These results will be helpful to conduct larger randomized trials with long term follow-up in order to prove the safety and effectiveness of PCI in such patients over coronary artery bypass grafting.

Keywords: Ejection fraction, Left ventricular dysfunction, Multi-vessel disease, Percutaneous coronary intervention

INTRODUCTION

Cardiovascular disease is one of the leading causes of mortality in the world, accounting for 29.3% of all deaths.¹ The burden from cardiovascular diseases are rapidly increasing in developing countries due to rapid population growth, ageing and globalized lifestyle.² Multi-vessel lesions are considered as an independent predictor of coronary artery disease (CAD) which commonly leads to serious complications such as heart enlargement, heart failure, malignant arrhythmias and

even sudden cardiac death, that impacts the quality of life and life expectancy of a patient.³

Coronary artery bypass graft surgery (CABG) has remained as the gold standard for the management of multi-vessel CAD, despite of technological advances in equipment and devices for percutaneous coronary intervention (PCI). The guidelines by ACC/AHA and ESC/EACTS also indicate CABG as the first line management strategy for the patients with multi-vessel CAD and depressed left ventricular ejection fraction.⁴⁻⁶ The patients with left ventricular (LV) dysfunction once

were considered poor candidates for percutaneous revascularization (PCI), because acute closure of lesions after balloon dilatation might result in death if the treated coronary artery supplied the only remaining viable myocardium. However, advances in technology have improved the efficacy and safety of PCI in patients with depressed LV ejection fraction (LVEF) as well.⁷ And in the era of novel drug eluting stent technology, multi-vessel angioplasty is set to make another leap forward with further expansion of the indications and improved outcomes.⁸ As most randomized clinical trials comparing CABG and PCI exclude patients with low LVEF, little information exists clarifying the optimum revascularization strategy in patients with severe LV dysfunction.⁹ The present study was carried out to analyse changes in baseline left ventricular function (with EF <40%) and clinical symptoms in multi-vessel CAD patients after multi-vessel PCI.

METHODS

This was a prospective, observational study conducted at Medical Super-speciality Hospital, Kolkata, India

between August 2017 and August 2019. Total 48 patients were enrolled in the study (based on statistical power of 90% at 5% level of significance). The ethical approval of the study was obtained from the institutional ethics committee of the hospital. The written informed consent was received from the patient or from patient's family members prior to the study.

Patients with age between 18-70 years, with ≥ 2 coronary artery stenosis of 50% or greater in native coronary arteries, with LVEF <40% and who were suitable for coronary stent implantation were included in the study. Before PCI relevant investigations like electrocardiography, echocardiography and angiography were performed to screen the patients. Subsequently, PCI was performed following standard guidelines by the interventional cardiologist. Echocardiography was also performed after 3 months of the procedure to observe LVEF in all the patients. Canadian Cardiovascular Society (CCS) score, defining stages of angina as per severity (Table 1) was calculated in all the patients before PCI and 3 months after PCI.

Table 1: Canadian cardiovascular society scoring of angina.

Score	Description
Score 1	<ul style="list-style-type: none"> • Ordinary physical activity does not cause angina, such as walking and climbing stairs. • Angina with strenuous/rapid/prolonged exertion at work or recreation.
Score 2	<ul style="list-style-type: none"> • Slight limitation of ordinary activity. • Walking/climbing stairs rapidly, walking uphill, walking/stair climbing after meals/in cold/ in wind/under emotional stress, or only during the few hours after awakening. • Walking more than two blocks on the level and climbing more than one flight of ordinary stairs at a normal pace and in normal conditions.
Score 3	<ul style="list-style-type: none"> • Marked limitation of ordinary physical activity. • Walking one/two blocks on the level and climbing one flight of stairs in normal conditions and at normal pace.
Score 4	<ul style="list-style-type: none"> • Inability to carry on any physical activity without discomfort, anginal syndrome may be present at rest.

All data were analysed using SPSS version 20 (IBM SPSS Statistics Inc., Chicago, Illinois, USA) windows software program. The level of significance was calculated by 95% confidence interval. Descriptive statistics included computation of percentages, means and standard deviations. The paired t-test and analysis of variance (ANOVA) were used for comparison of all clinical indicators. Chi-square test was used for qualitative data whenever two or more than two groups were compared. In this study, 5% level of significance ($p < 0.05$) was considered as statistically significant.

RESULTS

Majority of patients belongs to the age groups 50-60 (29.2%) years and 60-70 (37.5%) years. Mean age of patients was 61.89 ± 9.96 years. Among all patients,

89.6% patients were male and only 10.4% patients were female. Baseline and clinical characteristic of all the patients is displayed in (Table 2). Mean LVEF before and after angioplasty was $34.9 \pm 4.95\%$ and $42.06 \pm 8.78\%$, respectively ($p = 0.001$).

Before the treatment, mean CCS score was 2.89 which was decreased to 1.83 after the treatment ($p = 0.001$). There was gradual decrease in the number of patients in higher CCS scores after the treatment as compared to before the treatment with a statistically significant result ($p = 0.001$).

In patients with double vessel disease and triple vessel disease, mean LVEF increased from $35.13 \pm 4.82\%$ to $41.79 \pm 8.47\%$ and $32.5 \pm 6.45\%$ to $45.0 \pm 12.90\%$ after the treatment, respectively. Similarly, there was improvement

in CCS score after the treatment in both double vessel and triple vessel disease patients (2.88 ± 0.75 to 1.84 ± 0.96 and 3.00 ± 0.81 to 1.75 ± 0.95 , respectively). Two patients were implanted with single stent and both had CCS-score 1 after 3 months of PCI. Among 40 patients who were implanted with two stents, eighteen had CSS-score 1, twelve had CSS-score 2, seven had CSS-score 3 and three had CSS-score 4. Total 6 patients were implanted with three stents and after 3 months four patients had CSS-score 1, one had CSS-score 2 and one had CSS-score 3. (Table 3) depict the LVEF and CSS score pre-angioplasty and post-angioplasty.

DISCUSSION

Patients with CAD and severe LV dysfunction have a poor prognosis with medical treatment. In CASS trial, CABG improved overall prognosis in such patients with a survival rate of 63% compared to 43% in medical treatment at 5 years.¹⁰ However, the risks of CABG remain significant, particularly in patients with clinical evidence of congestive heart failure.¹¹ Notably, patients with severe LV dysfunction were usually excluded from the majority of randomized PCI vs. CABG trials.^{12,13} The present study displayed a hypothesis generative results which will help to conduct larger randomized trials to prove the safety and effectiveness of PCI in high-risk patients with depressed LV function and multi-vessel disease.

Table 2: Baseline demography and clinical characteristics of all the patients.

Characteristics		n = 48 patient
Age, years (mean \pm SD)		61.89 \pm 9.96
Age distribution, n (%)		
40-50 years		6 (12.5%)
51-60 years		14 (29.2%)
61-70 years		18 (37.5%)
71-80 years		7 (14.6%)
>80 years		3 (6.3%)
Male, n (%)		43 (89.6%)
Hypertension, n (%)		39 (81.3%)
Type-II Diabetes, n (%)		18 (37.5%)
Dyslipidaemia, n (%)		14 (29.2%)
Double vessel disease, n (%)		44 (91.7%)
Triple vessel disease, n (%)		4 (8.3%)
Number of stents implanted	One stent	2 (4.2%)
	Two stents	40 (83.3%)
	Three stents	6 (12.5%)
CCS Score	Pre-angioplasty	1 00
		2 16 (33.3%)
		3 21 (43.7%)
		4 11 (22.9%)
	Post-angioplasty	1 23 (47.9%)
		2 13 (27.1%)
		3 9 (18.7%)
		4 3 (6.25%)

Table 3: LVEF and CSS score in all the patients before and after angioplasty.

Parameters			Values	p-value
Ejection Fraction (%) (mean±SD)				
Pre-angiography			34.91±4.95	0.001
Post-angiography			42.06±8.78	
Pre-angiography	Double vessel disease		35.13±4.82	0.31
	Triple vessel disease		32.5±6.45	
Post-angiography	Double vessel disease		41.79±8.47	0.49
	Triple vessel disease		45.0±12.90	
Pre-angioplasty	CCS score	1	00	0.001
		2	38.75±2.88	
		3	34.9±3.23	
		4	29.36±4.92	
Post-angioplasty	CCS score	1	47.91±6.75	0.001
		2	40.69±3.42	
		3	34.11±7.13	
		4	27.00±2.64	
Post-angiography	Number of stents	1	55.00±7.07	0.06
		2	41.20±8.64	
		3	46.66±11.69	
CSS - score (mean±SD)				
Pre-angioplasty	Double vessel disease		2.88 ±0.75	0.77
	Triple vessel disease		3.0±0.81	
Post- angioplasty	Double vessel disease		1.84±0.96	0.85
	Triple vessel disease		1.75±0.95	

In the present study, overall 20% improvement in the ejection fraction was observed after PCI. Mean ejection fraction before stenting was 34.91%, whereas the mean ejection fraction after stenting was 42.06% ($p=0.001$). Similarly, the results obtained by Ottervanger JP et al, also reported 16% mean relative improvement in LVEF.¹⁴ In this study, LV function was improved in 48% patients; decreased in 25% patients, however no change was observed in remaining patients. Recent observational study on CABG in patients with depressed LVEF reported improved results even in patients with LVEF <25%; however larger trials are required to demonstrate the equivalent effectiveness of PCI with that of CABG in such patients.¹⁵ Furthermore, in the present study the functional status of each patient was assessed according to the CCS classification for angina (Table 1). In each patient the functional status before and after stenting was determined by consultation and physical examinations. In the present study, CCS classification improved significantly from 2.89 to 1.83 ($p = 0.001$) but due to paucity of the data in the previous literature finding couldn't be correlated.

In the recent era, the proportion of patients with multiple lesions or multi-vessel disease treated by implantation of multiple stents has been increasing. In the pre drug eluting stents period, Pan M et al, compared the clinical outcomes of patients with long diffuse stenosis treated by three different stenting strategies (one single long stent, overlapped multiple stents, and multiple non-overlapped stents) and; the cumulative incidence of major adverse cardiac events (death, acute myocardial infarction, and repeat revascularization) were similar in all three groups.¹⁶

This study included only multi-vessel disease patients that also with <40% LVEF. Various trials have demonstrated that multi-vessel PCI is associated with a greater incidence of recurrent angina necessitating another revascularization procedure compared to CABG.^{17,18} PCI has been recognised as an effective strategy in several complex cases as well and reduced the need for emergency or urgent CABG.^{19,20} However, the question is still unanswered, that whether the reduction in stent restenosis observed with drug eluting stents in simple lesions can be extended to multi-vessel disease or other complex lesions.^{21, 22} A study of Laham RJ et al, reported the results of multi-vessel stenting in 102 patients and the complications noted were mortality (1%); Q-wave MI (2%) and non-Q-wave MI (11%).²³ Importantly, no patients required emergent CABG at long-term follow-up and event-free survival was 79%. Similarly, Moussa I et al, reported the results of 100 patients who underwent multi-vessel coronary stenting and during follow-up 4% mortality was reported.²⁴ In that study, 4% patient required emergent CABG and 2% patients required target vessel revascularization. These results altogether suggest that multi-vessel stenting may be a viable therapeutic strategy in aptly selected multi-vessel CAD patients.

Study limitations includes, repeat angiography or any stress testing after PCI were not performed; therefore authors were able to ascertain adequate revascularization of all segments. In this study population, only serial LVEF was measured. Diastolic LV dysfunction, or LV dimensions, including end-diastolic or end-systolic volumes were not measured which could have provided additional information on the remodeling process. Furthermore, follow-up 2D-echocardiography was performed at 3 months after the procedure, and some reports have demonstrated ongoing remodeling beyond this period. Moreover, author had no data on the extent of possible influence of collaterals on recovery of LV function. Since author had no follow-up data after 3 months, it was not possible to evaluate whether a change in LV function is also associated with a change in prognosis. Future follow-up studies should be performed to evaluate this.

CONCLUSION

In conclusion, this observational study suggests that in clinically selected patients of multi-vessel coronary artery disease who have severe LV dysfunction; with percutaneous coronary intervention there is improvement in LV function and overall clinical symptoms. These results suggest that the percutaneous treatment of stenosis is an effective and safe alternative in this well-defined population. The results are hypothesis generating and should be tested in future by conducting more prospective controlled trials with defined criteria for treatment assignment and long-term follow-up is also needed.

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