

# In-Hospital Outcome of Percutaneous Coronary Interventions in Patients with Left Ventricular Systolic Dysfunction

A. Yousefi MD, H. R. Sanati MD, N. Salehi MD, M. Maadani MD,  
F. Shakerian MD, A. Firoozi MD and M. Esmaili MD

## Abstract

**Background-** Left ventricular dysfunction is considered a high-risk condition for performing either percutaneous or surgical revascularization. The aim of this study was to evaluate immediate procedural and clinical outcomes and in-hospital complications of percutaneous coronary interventions (PCI) in patients with coronary artery disease (CAD) and ventricular systolic dysfunction.

**Methods-** Four hundred consecutive patients with documented obstructive CAD and left ventricular systolic dysfunction (EF <45%) were selected. Left ventricular ejection fraction was assessed via transthoracic echocardiography at the time of hospitalization. Indications for PCI were made on the basis of clinical and non-invasive studies. The majority of the patients (75%) were males, and their mean age was 55.9±10.7 years. More than half of the patients (56.78%) had multi-vessel disease. Multi-vessel PCI was performed in 51 (12.85%) patients. A total of 397 stents were implanted (0.99 stent/patient).

**Results-** Technical procedural success was obtained in 96.75% of the patients. Procedural death was not seen. Non-Q wave acute myocardial infarction occurred in 12 (3%) patients, Q-wave AMI in four (1%), emergency coronary artery bypass grafting in six (1.5%), and cardiogenic shock in three (0.75%). Stroke did not occur in any cases. Major bleeding occurred in one (0.25%) patient, and 4.2% of the patients experienced minor bleeding.

**Conclusions-** In patients with CAD and left ventricular systolic dysfunction, PCI can be performed with a good procedural outcome and acceptable in-hospital complications (*Iranian Heart Journal 2008; 9 (4):13-18*).

**Key words:** coronary artery disease ■ left ventricular dysfunction ■ percutaneous coronary intervention

Left ventricular dysfunction is considered a high risk condition for performing either percutaneous or surgical revascularization. Acute myocardial infarction (AMI) is the main cause of systolic dysfunction in patients with coronary artery disease (CAD), but in some cases chronic ischemia can result in myocardial hibernation and dysfunction.

Medical therapy was considered traditionally as a routine management strategy in these patients, mostly because of a common misconception that revascularization cannot be effective in the case of myocardial dysfunction. High-risk status is another factor that pushes these patients away from invasive revascularization through percutaneous

Received June 21, 2007; Accepted for publication Dec. 26, 2008.

From the Dept. of Interventional Cardiology, Shaheed Rajaie Cardiovascular Medical and Educational Center, Iran University of Medical Sciences, Tehran, Iran.

Address correspondence to: H. R. Sanati MD, Assistant Professor of Cardiology, Shaheed Rajaie Cardiovascular Medical and Educational Center, Iran University of Medical Sciences, Tehran, Iran.

Tel: 021-23922355

coronary intervention (PCI) or coronary artery bypass grafting (CABG).

Such patients have very limited survival when treated medically<sup>2,3</sup> and usually die of cardiac causes related to recurrent ischemia or infarction, heart failure, or ventricular arrhythmias.

In patients with left ventricular dysfunction, revascularization is indicated when myocardial viability is documented by non-invasive tests and can lead to better short- and long-term survival. However, it must be considered that poor left ventricular function, *per se*, is associated with high-risk in-hospital course and suboptimal short- and long-term results.

CABG has been considered to date the standard treatment for CAD in patients with left ventricular dysfunction. But in common practice, PCI has also been employed in selected patients.

The aim of this study was to evaluate the immediate procedural and clinical outcome and in-hospital complications of PCI in patients with CAD and ventricular systolic dysfunction.

## Methods

We selected 400 consecutive patients with documented obstructive CAD, ventricular systolic dysfunction (EF <45%), and evidence of viable myocardium, undergoing PCI between August 2006 and August 2007 in our center. Left ventricular ejection fraction (LVEF) was assessed via transthoracic echocardiography at the time of hospitalization. Indications for PCI were made by the attending physician after having reviewed the coronary angiography on the basis of clinical and non-invasive evaluations. After assessing the coronary anatomy via coronary angiography, PCI was performed in the routine manner. Intention to treat was for complete revascularization via PCI in all the patients, and the patients were followed up during the hospital course. Clinical status was assessed frequently. Post-procedural

electrocardiograms and biochemical markers (CK-MB) were evaluated, and the occurrence of cardiac and non-cardiac death, myocardial infarction (non-Q and Q-wave), and minor and major bleeding, stroke, and need for emergent revascularization were recorded.

The collected data were analyzed using SPSS software using descriptive statistical analysis such as numerical and central indices and distribution.

## Results

The demographic and clinical characteristics of the study patients are shown in Table 1. The majority (75%) of the patients were male, and their mean age was 55.9±10.7 years. Coronary risk factors were common: 56 percent of the patients had experienced a previous Q wave or non-Q myocardial infarction. Seventy-five (19%) patients had undergone previous myocardial revascularization: 44 (11%) by PCI, 28 (7%) by CABG, and 3 (1%) by both.

**Table I. Demographic and clinical characteristics**

<b>No. of Patients=400</b>	
Age	55.9±10.7
Sex: male/female	300/100
Coronary risk factors:	
Dyslipidemia	67%
Hypertension	51%
Diabetes mellitus	32%
Cigarette smoking	55%
Family history	33%
Previous AMI	56%
Previous PCI	11%
Previous CABG	7%

The angiographic characteristics are summarized in Table II. One hundred two (43.22%) patients had single-vessel disease

and 228 (56.78%) had multi-vessel disease. The left anterior descending (LAD) artery was the most commonly treated vessel (61.9%), followed by the right coronary artery (18.5%), left circumflex artery (12.2%), marginal branches (3.8%), diagonal branches (0.9%), LIMA (0.2%), saphenous vein grafts (2%), and protected left main artery (0.2%). Multi-vessel PCI was performed in 51 (12.85%) patients. A total of 397 stents were implanted (0.99 stent/patient).

**Table II. Angiographic and procedural data**

No. of patients=400	
-Single-vessel disease	172 (43.22%)
-Multi-vessel disease	228 (56.78%)
No. of treated vessels=442	
LAD	274 (61.9%)
Diagonal	4 (0.9%)
LCX	54 (12.2%)
Marginal	17 (3.8%)
RCA	82 (18.5%)
LIMA	(0.2%)
SVG	9 (2%)
LMCA: Protected	(0.2%)
Unprotected	0
No. of stents implanted	397 0.99 stent/patient
Multi-vessel PCI	51 (12.85%)
LVEF	
36-44	304 (76%)
26-35	85 (21.25%)
<25	11 (2.75%)

### ***Procedural and in-hospital outcomes***

All the patients received routine antiplatelet therapy prior to the procedure and continued it on the basis of the current guidelines. GpIIb/IIIa inhibitors were not administered routinely. Technical procedural success was

obtained in 96.75% of the patients. Procedural death was not seen. Non Q-AMI occurred in 12 (3%) patients, Q-AMI in 4 (1%), emergency CABG in 6 (1.5%), and cardiogenic shock in 3 (0.75%). Stroke did not occur in any cases. Major bleeding occurred in 1 (0.25%) patient, and 4.2% of the patients experienced minor bleeding.

**Table III. Procedural and in-hospital outcome**

No. of patients=400	
Procedural success	387 (96.75%)
In-hospital death	0
Non Q-AMI	12 (3%)
Q-AMI	4 (1%)
Stroke	0
Emergent CABG	6 (1.5%)
Cardiogenic shock	3 (0.75%)
Major bleeding	1 (0.25%)
Minor bleeding	17 (4.2%)

### **Discussion**

Few studies have investigated immediate and long-term outcomes of patients with left ventricular systolic dysfunction undergoing percutaneous coronary revascularization.<sup>2-10</sup> Technical advances in PCI with widespread use of coronary stents and potent oral and intravenous antiplatelet therapies have resulted in expanded indications, even in patients considered as high risk,<sup>11</sup> as was the case in those included in the present study. Indeed, the greatest improvements have been seen in high-risk patients and more complex procedures. Patients with left ventricular dysfunction have remained a subset of patients that are less often treated percutaneously. Moreover, given the substantial operative risk whenever systolic function is reduced, perhaps even coronary bypass surgery is performed less frequently than indicated in such patients. With the

exclusion of some pivotal studies focusing on balloon-only interventions, such as the BARI trial<sup>12</sup> and the AWESOME study,<sup>13</sup> in most new studies percutaneous revascularization could be safely accomplished, with in-hospital mortality rates as low as 0<sup>14</sup> and as high as 3%.<sup>15-17</sup> The DYNAMIC Registry<sup>15</sup> showed an increased in-hospital MACE (including mortality) in patients with left ventricular ejection fraction <40% undergoing PCI. In our analysis, in-hospital mortality did not occur in the study patients. This was one of the striking findings of this study. Mortality rates in previous studies are shown in Table IV.

**Table IV. Mortality rates in previous studies of PCI in patients with LV dysfunction**

Study	EF	Death
REHEAT	≤ 40%	2.4%
Marsico	≤ 35%	1.6%
Lindsay	≤ 30%	2.6%
Paul	≤ 40%	3%
Miwako	≤ 40%	8.1%
Kohli	≤ 35%	3.2%

We found an acceptable rate of in-hospital MACE, as shown in Table III. Different studies have revealed various rates of in-hospital MACE, from 1.3% to 19.5%. Myocardial infarction was also less frequent in this study compared with that in some other studies (Table V).

Given that we did not use GpIIb/IIIa inhibitors in many of these high-risk patients because of financial issues and that intra-aortic balloon pump was used very selectively (two effective strategies in high-risk patients

undergoing PCI, like those with LV systolic dysfunction), early results seem favorable.

**Table V. In-hospital MACE outcomes in previous studies**

		Death	MI
Briguori et al.	7.5%	3%	4.5%
Bukachi et al.	19.5%	2.4%	14.6%
Di Sciascio et al.	1.3%	0	1.3%
Keelan et al.	6.6%	3%	3%
Sheiban et al.	6.4%	2.6%	6.8%
Marisco et al.	3.2%	1.6%	1.6%
Li et al.	2.7%	1.4%	2.7%

On the other hand, it should be emphasized that most of our patients did not have severe LV dysfunction. This lower-risk profile can be one of the reasons for acceptable in-hospital prognosis in the study patients.

Patients with severe left ventricular dysfunction (EF <25%) had a higher frequency of complex lesions compared with patients with higher ejection fractions (P-value=0.014). This complexity of lesions can be the result of the severity of the baseline pathogenic disease, leading to more severe myocardial dysfunction. Therefore, they are a special subgroup in patients with LV dysfunction that may earn greatest benefits from adjunctive therapies such as GpIIb/IIIa inhibitors. Li et al. did not consider diabetes mellitus as an independent risk factor for a poor in-hospital outcome after elective PCI. The same result was seen in this study.

In general, the current data support the application of percutaneous revascularization in patients with variable degrees of LV dysfunction with careful patient selection and strategy.

**Conflict of Interest**

No conflicts of interest have been claimed by the authors.

## References

1. Bourassa MG, Gurne O, Bangdiwala SI, Ghali JK, Young JB, Rousseau M, Johnstone DE, Yusuf S. Natural history and patterns of current practice in heart failure. *J Am Coll Cardiol* 1993; 22(suppl A): 14A-19A.
2. Beanlands RS, Hendry PJ, Masters RG, deKemp RA, Woodend K, Ruddy TD. Delay in revascularization is associated with increased mortality rate in patients with severe left ventricular dysfunction and viable myocardium on fluorine 18-fluorodeoxyglucose positron emission tomography imaging. *Circulation* 1998; 98: 51-6.
3. Luciani GB, Faggian G, Razzolini R, Livi U, Bortolotti U, Mazzucco . Severe ischemic left ventricular failure: coronary operation or heart transplantation? *Ann Thorac Sur* 1993; 55: 719-723.
4. Hartzler GO, Rutherford BD, McConahay DR, Johnson WL, Giorgi LV. High risk percutaneous transluminal coronary angioplasty. *Am J Cardiol* 1988; 61(14): 33G-37G.
5. Stevens T, Kahn LK, McCallister BD, Ligon RW, Spaude S, Rutherford BD, McConahay DR, Johnson WL, Giorgi LV, Shimshak TM. Safety and efficacy of percutaneous transluminal coronary angioplasty in patients with left ventricular dysfunction. *Am J Cardiol* 1991; 68(4): 313-9.
6. Serota H, Deligonul U, Lee WH, Aguirre F, Kern MJ, Taussig SA, Vandormael MG. Predictors of cardiac survival after percutaneous transluminal coronary angioplasty in patients with severe left ventricular dysfunction. *Am J Cardiol* 1991; 67: 367-372.
7. Reynen K, Kunkel B, Gansser R, Bachmann K. Percutaneous transluminal coronary angioplasty in patients with severely depressed left ventricular function. *Cardiology* 1993; 83(5-6): 358-66.
8. Holmes Dr Jr, Detre KM, Williams DO, Kent KM, King SB 3rd, Yeh W, Steenkiste A. Long-term outcome of patients with depressed left ventricular function undergoing percutaneous transluminal coronary angioplasty. The NHLBI PTCA Registry. *Circulation* 1993; 87(1): 291-3.
9. Maiello L, Colombo A, Gianrossi R, Almagor Y, Finci L. Survival after percutaneous transluminal coronary angioplasty in patients with severe left ventricular dysfunction. *Chest* 1994; 105(3): 733-40
10. Beurrier D, Tricoche O, Feldmann L, Juilliere Y, Buffet P, Anconia J, Cherrier F, Danchin N. Transluminal coronary angioplasty in patients with left ventricular dysfunction; immediate and long term results. *Arch Mal Coeur et Vaiss* 1995; 88(2): 225-30.
11. Yang EH, Gumina RJ, Lennon RJ, Holmes DR jr, Rihal CS, Singh M. Emergency coronary artery bypass surgery for percutaneous coronary interventions: changes in the incidence, clinical characteristics, and indications from 1979 to 2003. *J Am Coll Cardiol* 2005; 46: 429-33.
12. Berger PB, Velianou JL, Aslanidou Vlachos H, Fiet F, Jacobs AK, Faxon DP, Attubato M, Keller M, Stadius ML, Weiner BH, Williams DO, Detre KM; BARI investigators. Survival following coronary angioplasty versus coronary artery bypass surgery in anatomic subsets in which coronary artery bypass surgery improves survival compared with medical therapy. Results from the Bypass Angioplasty Revascularization Investigation (BARI). *J Am Coll Cardiol* 2001; 38: 1440-9.
13. Morrison DA, Sethi G, Sacks J, Henderson W, Grover F, Sedlis S, Esposito R, Ramanathan K, Weiman D, Saucedo J, Antakli T, Paramesh V, Vernon S, Birjiniuk V, Welt F, Krucoff M, Wolfe W, Lucke JC, Mediratta S, Booth D, Barbieri C, Lewis D; Angina With Extremely Serious Operative Mortality Evaluation (AWESOME). Percutaneous coronary intervention versus coronary artery bypass graft surgery for patients with medically refractory myocardial ischemia and risk factors for adverse outcomes with bypass: a multicenter, randomized trial. Investigators of the Department of Veterans Affairs Cooperative Study #385, the Angina With Extremely Serious Operative Mortality Evaluation (AWESOME). *J Am Coll Cardiol* 2001; 38: 143-9.
14. Aslam F, Blankenship JC. Coronary artery stenting in patients with severe left ventricular dysfunction. *J Invasive Cardiol* 2005; 17: 656-8.

15. Keelan PC, Johnstone AM, Koru-Sengul T, Detre KM, Williams DO, Slater J, Block PC, Holmes DR Jr; Dynamic Registry investigators. Comparison of in-hospital and one-year outcomes in patients with left ventricular ejection fraction <40%, 41% to 49% and >50% having percutaneous coronary revascularization. *Am J Cardiol* 2003; 91: 1168-1172.
16. Lipinski MJ, Martin RE, Cowley MJ, Goudreau E, Malloy WN, Vedrovec GW. Improved survival for stenting vs. balloon angioplasty for the treatment of coronary artery disease in patients with ischemic left ventricular dysfunction. *Catheter Cardiovasc Interv* 2005; 66: 547-53.
17. Briguori C, Sarais C, Pagnotta P, Airolidi F, Liistro F, Sgura F, Spanos V, Carlino M, Montorfano M, Di Mario C, Colombo A. Elective versus provisional intra-aortic balloon pumping in high-risk percutaneous transluminal coronary angioplasty. *Am Heart J* 2003; 145: 700-7.