

## Effect of Elective Percutaneous Coronary Intervention on Left Ventricular Function in Patients with Coronary Artery Disease

Younes Nozari<sup>1</sup>, Nader Jangi Oskouei<sup>2</sup>, and Zahra Khazaeipour<sup>3</sup>

<sup>1</sup> Department of Cardiology, Tehran Heart Center, Tehran University of Medical Sciences, Tehran, Iran

<sup>2</sup> Department of Cardiology, Imam Khomeini Hospital, Tehran University of Medical Sciences, Tehran, Iran

<sup>3</sup> Research Deputy of Imam Khomeini Hospital Complex, Brain and Spinal Injury Repair Research Center, Tehran University of Medical Sciences, Tehran, Iran

Received: 25 Mar. 2011; Received in revised form: 2 Aug. 2011; Accepted: 29 Aug. 2011

**Abstract-** Coronary artery disease is one of the most common causes of mortality and morbidity across the world. Its treatment includes medical treatment, coronary artery bypass graft (CABG) and percutaneous coronary intervention (PCI). The purpose of this study was to investigate the effect of PCI on echocardiographic findings of left ventricular (LV) systolic and diastolic function. 115 patients with coronary artery disease candidate for PCI were enrolled to our study. Echocardiography was done before PCI, the day after and 3-6 months later. LV systolic and diastolic function were measured and recorded. Echocardiographic finding compared with repeated measurement analysis. Mean age of the patients was  $57.8 \pm 8.38$  years. The mean Ejection Fraction (EF) was ( $\%40.52 \pm 6.36$ ) before, ( $\%41.83 \pm 7.14$ ) the day after, and ( $\%44.0 \pm 7.89$ ) 3-6 months after PCI. Diastolic dysfunction were mild to moderate before PCI, which in  $\%74$  (86 patients) were improved to mild dysfunction the day after PCI but not changed 3-6 months later ( $P < 0.0001$ ). PCI improved LV ejection fraction, and LV diastolic function in our patient's population.

© 2012 Tehran University of Medical Sciences. All rights reserved.

*Acta Medica Iranica*, 2012; 50(1): 26-30.

**Keywords:** PCI (Percutaneous Coronary Intervention); CABG (Coronary Artery Bypass Graft); CAD (Coronary Artery Disease); EF (Ejection Fraction); LV diastolic function

### Introduction

Cardiovascular diseases is one of the most common and serious disease throughout the world and the most cause of mortality and morbidity worldwide (1). Coronary artery disease (CAD) is one of the most important in this group (2). It has been expected that the mortality rate of CAD increases in the developing countries (3). Myocardial necrosis following myocardial infarction (MI) causes LV dilatation, followed by LV systolic dysfunction as a result of cardiac remodeling. Cardiac remodeling is a determinant of clinical course of heart failure (4).

Medical treatment, (PCI) and CABG are the treatment options for CAD (5). The basis of pathophysiologic benefit of revascularization is improving the function of viable myocardium (6).

Early coronary re-canalization helps to survive the viable myocardium and improve global LV function and

survival (7). According to the studies in patients with CAD and LV dysfunction, the disease outcome can be improved with surgical revascularization (CABG) or PCI (6).

In comparison between PCI and CABG, it has been shown that PCI is less aggressive than CABG, is less costly, can be done just after angiography, needs less hospitalization and has fewer complications (8). PCI in patients with preserved LV function and optimal medical therapy doesn't reduce the cardiac death and MI, but it decreases the need for other procedure and the risk of angina. Its effect on LV systolic or diastolic function is not clear (8).

Primary PCI is performed in the stage of acute MI, late PCI is carried out some days after acute MI, and elective PCI is done in CAD patients who are candidate for PCI in diagnostic processes.

PCI has been used increasingly for revascularization in ischemic heart disease (IHD) patients. In most of the

**Corresponding Author:** Zahra Khazaeipour

Preventive and Community Medicine Specialist, Research Deputy of Imam Khomeini Hospital Complex, Brain and Spinal Injury Repair Research Center, Tehran University of Medical Sciences. Keshavarz Blvd., Tehran, Iran.

Tel: +98 21 66581538, 912 5146752, Fax: +98 21 66581519, E-mail: khazaeipour@gmail.com, khazaeipour@razi.tums.ac.ir

studies, the primary PCI, criterion such as ejection fraction (EF), diastolic function and the wall motion or chamber sizes has been investigated. Result of previous studies in related area, about elective PCI, has shown unequal viewpoints (7,10,11,13,14). Intervals between MI and PCI, basic left ventricular ejection fraction (LVEF) before PCI and global condition of the patients affect the result of PCI.

Limited number studies have been done in Iran to study the effect of PCI on cardiac function. The present study was aimed to investigate the effect of elective PCI of LV function in our cardiac center.

Materials and Methods

This assessment is a cohort study comparing echocardiographic finding before and after PCI in 115 CAD patients, candidate for elective PCI in our cardiac center.

Exclusion criteria were: Unsuccessful PCI, primary valvulopathy, pericardial effusion, myocarditis or pericarditis, known case of cardiomyopathy, poor echo window patients, patients with complete normal echocardiography, and patients with poor cooperation.

Before intervention echocardiography was done and LV ejection fraction and diastolic function was assessed.

LV ejection fraction was measured by visual measurement (eye balling). Because of regional wall motion abnormality, Simpson’s method was not used (9). Patients were subdivided into four groups:

Group 1: severe LV systolic dysfunction with LVEF less than 30%.

Group 2: moderate LV systolic dysfunction with LVEF between 30-40%.

Group 3: mild LV systolic dysfunction with LVEF 45% (41- 49%).

Group 4: relatively preserved LV systolic function with more than 50%.

Diastolic function was assessed by Doppler echo and Tissue Doppler Imaging (TDI). Based on E, A, E/A, E’, A’, DT, E/E’ measurements, patients were subdivided into mild, moderate and severe LV diastolic dysfunction (9).

Echocardiographic finding of patients was saved and the day after PCI and 3-6 months later echocardiography was repeated and the same process was carried out.

Results

In 115 patients meeting the selection criteria mean age was 57.8±8.38 years. Mean age of men was 58±8.37 (35-75) years and for women was 57.1±8.51 (43-76) years. Earliest interval of MI and PCI was 3 weeks.

According to the history and ECG, 98 patients (85.2%) had a history of MI and 17 patients (14.78%) had no history of MI. 35 patients (30.43%) had no risk factor (Diabetes mellitus, hypertension, hyperlipidemia and smoking), 56 patients (48.69%) had one risk factor, 24 patients (20.86%) had more than one risk factor.

The Baseline characteristics of the population are summarized in Table 1.

71 patients (61.7%) had PCI on left anterior descending (LAD), 11 patients (9.6%) had on right coronary artery (RCA), 12 patients (10.4%) had intervention on left circumflex artery (LCX), 15 patients (13%) had PCI on LCX+LAD, and 6 patients (5.2%) had on RCA + LAD.

Overall, 94 patients (81.73%) had the procedure on one artery, and 21 patients (18.26%) had intervention on two arteries (Figure 1).

Table 1. Baseline characteristic of patients.

|                                    |             |
|------------------------------------|-------------|
| Male/female no                     | 86/29       |
| Mean age (mean ± SD)               | 57.8±8.38   |
| Male mean age                      | 58.0±8.37   |
| Female mean age                    | 57.1±8.51   |
| Male/female rang of age            | 35-75/43-76 |
| History of acute coronary syndrome | 98 (85.2%)  |
| <i>Risk Factors</i>                |             |
| Diabetes mellitus                  | 28 (24.34%) |
| Hypertension                       | 28 (24.34%) |
| Hyperlipidemia                     | 34 (29.56%) |
| Smoking                            | 25 (21.73%) |

Table 2. Mean ejection fraction during 3 stages of measurement.

|        | Stage 1 (before PCI) | Stage 2 (one day after PCI) | Stage 3 (3-6 months after PCI) |
|--------|----------------------|-----------------------------|--------------------------------|
| Male   | 40.17±6.62           | 41.34±7.33                  | 43.37±8.24                     |
| Female | 41.55±5.53           | 43.28±6.45                  | 45.86±6.56                     |
| Total* | 40.52±6.36           | 41.83±7.14                  | 44.0±7.89                      |

\* Repeated Measurement analysis P<0.0001

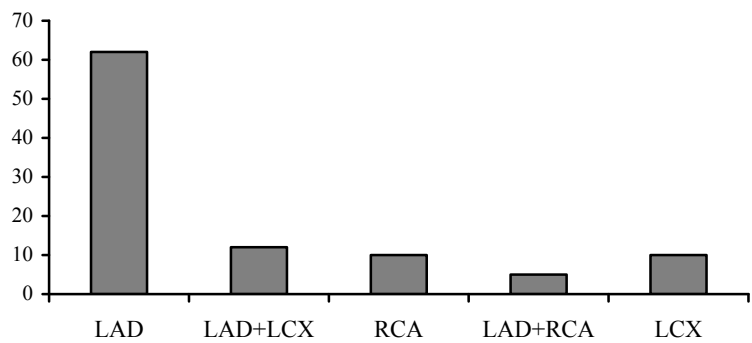


Figure 1. Frequency of PCI vessels.

Ejection Fraction (EF) significantly increased during 3 stages of measurements ( $P<0.0001$ ). There was no differences in this changes between genders ( $P=0.2$ ), and type of vessel ( $P=0.09$ ), this increase in 2 groups with and without history of acute coronary syndrome (ACS) was the same, but EF was different in 2 groups ( $P<0.0001$ ). Mean EF during 3 stages are showed at table 2.

In the first group (10 patients; 8.69%), EF before PCI was 25%, and didn't show improvement the day after intervention and 3-6 months later. 46 patients (40%) in the second group had mean EF of %37.8, next day after PCI it became 38.9% and 3-6 months later was 41%. In

the third group (56 patients; 48.69%), EF was 45%, 46.7% and 49.4% in different stages of study respectively. In the last group (group 4, 3 patients: 2.6%), EF was 50% and didn't change after PCI (one day and 3-6 months later). Increase of EF was more obvious in patients who had basic EF 40% and 45%.

Diastolic dysfunction significantly improved the day after PCI ( $P<0.0001$ ), and no obvious changes were seen in the results of one day after PCI with the results of 3-6 months later. There was no differences in this changes between genders ( $P=0.2$ ), history of ACS ( $P=0.2$ ) and type of vessel ( $P=0.07$ ).

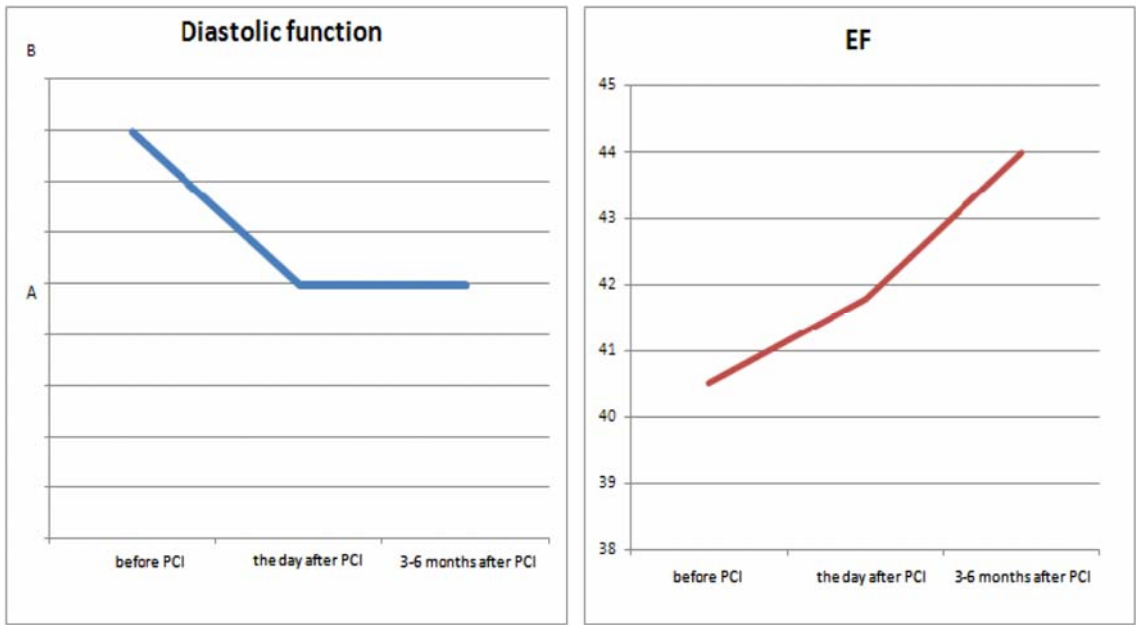


Figure 2. Changes of LVEF and diastolic function before and after PCI. A (mild diastolic dysfunction), B (moderate diastolic dysfunction).

Before PCI, 49 patients (42.6%) had mild, 62 patients (53.9%) had moderate and 4 patients (3.5%) had severe LV diastolic dysfunction. The day after PCI, 12 patients (10.4) had near normal to mild, 96 patients (83.5%) had mild, and 7 patients (6.1%) had moderate LV diastolic dysfunction (Figure 2).

## Discussion

In this study, we assessed 115 patients by echocardiography before and after PCI. Significant improvement in LVEF was found the day after PCI and 3-6 months later.

Silva *et al.* have shown that late recanalization, 12 hours to 14 days post anterior MI improved LV EF and myocardial contractility (7). Buszman *et al.* revealed that LVEF was increased  $6 \pm 7.2$  after PCI (10).

Improvement of LVEF was seen in two other studies by Nechvatal *et al.* (11) and Ioannidis *et al.* (12).

LVEF received from  $40 \pm 17$  to  $54 \pm 15$  in Rummelink *et al.* report (13) and from  $48.8 \pm 11.6$  to  $52.5 \pm 11.5$  in Agirbasli *et al.* study (14).

Banerjee *et al.* in another study reported that late PCI on persistent total occlusion 3-28 days after MI did not reduce rate of death, re-infarction, heart failure and no change was observed in LVEF compared with optimal medical therapy (15). On the other hand, Carluccio *et al.* demonstrated that PCI improved LVEF (from 32% to 43%;  $P=0.0004$ ) and diastolic function (16).

Discrepancy between various studies may be from: interval between MI and PCI, basic LVEF before PCI, global condition of the patients and degree of coronary artery stenosis. In our study, no change in LVEF at level of 30% or less and 50% were seen. The most improvement of LVEF was seen at 40% and 45% level.

In this study, improvement of LV diastolic function was found the day after PCI but 3-6 months later no change was observed.

Tanaka *et al.* studied 27 patients and showed improvement in left ventricular early diastolic filling after PCI (17). Improvement of LV diastolic function was also reported by Carluccio *et al.* which was mentioned above (16).

Improving of myocardial function including EF and diastolic function after revascularization may be due to improved perfusion at stunning area. Regarding to the achievement of various results in current and previous studies in one hand, and many influencing factors such as (interval between MI and PCI, basic LVEF before PCI and etc.) in the other hand, it seems more and long

term investigation is required for obtaining more meaningful findings.

## Acknowledgments

The authors express gratitude to all personnel's of Imam Khomeini Cat lab and Echo lab for theirs technical assistance, as well as to Elham Aalamimilani for her cooperation.

## References

1. Gaziano JM, Manson JE, Ridker PM. Primary and secondary prevention of coronary heart disease. In: Libby P, Bonow RO, Mann DL, Zipes DP, editors. Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine. 8<sup>th</sup> ed. St. Louis, Mo: WB Saunders; 2007. p. 1119-45.
2. Hiatt WR, Cooke JP. Atherogenesis and the medical management of atherosclerosis. In: Rutherford RB, editor. Vascular Surgery. 5<sup>th</sup> ed. Philadelphia, PA: WB Saunders Co.; 2000. Vol. 1. p. 333-46.
3. Okrainec K, Banerjee DK, Eisenberg MJ. Coronary artery disease in the developing world. Am Heart J 2004;148(1):7-15.
4. Banerjee P, Card D. Preserving left ventricular function during percutaneous coronary intervention. J Invasive Cardiol 2007;19(10):440-3.
5. Rihal CS, Raco DL, Gersh BJ, Yusuf S. Indications for coronary artery bypass surgery and percutaneous coronary intervention in chronic stable angina: review of the evidence and methodological considerations. Circulation 2003;108(20):2439-45.
6. Phillips HR, O'Connor CM, Rogers J. Revascularization for heart failure. Am Heart J 2007;153(4 Suppl):65-73.
7. Silva JC, Rochitte CE, Júnior JS, Tsutsui J, Andrade J, Martinez EE, Moffa PJ, Menegheti JC, Kalil-Filho R, Ramires JF, Nicolau JC. Late coronary artery recanalization effects on left ventricular remodelling and contractility by magnetic resonance imaging. Eur Heart J 2005;26(1):36-43.
8. Lane GE, Holmes DR Jr. Primary percutaneous coronary intervention in the management of acute myocardial infarction. In: Libby P, Bonow RO, Mann DL, Zipes DP, editors. Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine. 8<sup>th</sup> ed. St. Louis, Mo: WB Saunders; 2007. p. 1301-11.
9. Connolly HM, Oh JK. Echocardiography. In: Libby P, Bonow RO, Mann DL, Zipes DP, editors. Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine. 8<sup>th</sup> ed. St. Louis, Mo: WB Saunders; 2007. p. 227-326.

10. Buszman P, Szkróbka I, Gruszka A, Parma R, Tendera Z, Leško B, Wilczyński M, Bochenek T, Wojakowski W, Bochenek A, Tendera M. Comparison of effectiveness of coronary artery bypass grafting versus percutaneous coronary intervention in patients with ischemic cardiomyopathy. *Am J Cardiol* 2007;99(1):36-41.
11. Nechvatal L, Hlinomaz O, Groch L, Hornacek I, Sitar J, Orban M, Petrikovits E. Serial echocardiographic assessment of the left ventricular function after direct PCI. *Kardiolog Pol* 2003;59(11):397-401.
12. Ioannidis JP, Katritsis DG. Percutaneous coronary intervention for late reperfusion after myocardial infarction in stable patients. *Am Heart J* 2007;154(6):1065-71.
13. Rummelink M, Sjaauw KD, Henriques JP, Vis MM, van der Schaaf RJ, Koch KT, Tijssen JG, de Winter RJ, Piek JJ, Baan J Jr. Acute left ventricular dynamic effects of primary percutaneous coronary intervention from occlusion to reperfusion. *J Am Coll Cardiol* 2009;53(17):1498-502.
14. Agirbasli M, Guler N. Recovery of left ventricular systolic function after left anterior descending coronary artery stenting. *J Interv Cardiol* 2005;18(2):83-8.
15. Banerjee P, Banerjee T, Khand A, Clark AL, Cleland JG. Diastolic heart failure: neglected or misdiagnosed? *J Am Coll Cardiol* 2002;39(1):138-41.
16. Carluccio E, Biagioli P, Alunni G, Murrone A, Leonelli V, Pantano P, Vincenti G, Giombolini C, Ragni T, Reboldi G, Gentile F, Ambrosio G. Effect of revascularizing viable myocardium on left ventricular diastolic function in patients with ischaemic cardiomyopathy. *Eur Heart J* 2009;30(12):1501-9.
17. Tanaka H, Kawai H, Tatsumi K, Kataoka T, Onishi T, Nose T, Mizoguchi T, Yokoyama M. Improved regional myocardial diastolic function assessed by strain rate imaging in patients with coronary artery disease undergoing percutaneous coronary intervention. *J Am Soc Echocardiogr* 2006;19(6):756-62.
18. Shewan LG, Coats AJ. Ethics in the authorship and publishing of scientific articles. *Int J Cardiol* 2010;144:1-2.