

## Original article

### Assessment the clinical and paraclinical effects of enhanced external counter pulsation therapy in patients with coronary artery disease

Shervin ziaabakhsh Tabary<sup>1</sup>, Keyvan Yousefnejad<sup>2</sup>, Taraneh Ziaee<sup>3</sup>, Mehran Fazli<sup>4\*</sup>

1. Cardiac surgery department, Fatemeh Zahra hospital of Sari, Mazandaran University of Medical Sciences, Sari, Iran
2. Department of Cardiology, Faculty of Medicine, Mazandaran University of Medical Sciences, Sari, Iran
3. Faculty of Medicine, Student Research Committee, Mazandaran University of Medical Sciences, Sari, Iran
4. General Practitioner in Imam Khomeini Hospital of Esfarayen, Esfarayen Faculty of Medical Sciences, Esfarayen, Iran

Corresponding author: Mehran Fazli Email: [mehran222@gmail.com](mailto:mehran222@gmail.com)

#### Abstract

**Background:** the aim of this study was assessment the clinical and paraclinical effects of enhanced external counter pulsation (EECP) therapy in patients with coronary artery disease.

**Patients and Methods:** We performed a retrospective analysis of data related to all patients who received EECP treatment at Shafa hospitals in Sari, Iran from 21 March 2013 to 21 March 2015. All patient's data included demographic data, history of underlying disease, clinical sign and symptom, laboratory data (hemoglobin, triglyceride (TG), cholesterol, Low-density lipoprotein (LDL), High-density lipoprotein (HDL)) and left ventricular ejection fraction (LVEF) in before and after treatment by EECP were collected.

**Results:** the data of 48 patients (include 25 men) with mean age of  $62.20 \pm 10.15$  years were collected. The mean of TG, Cholesterol, LDL and HDL were not significantly change after EECP therapy. However, the mean of hemoglobin ( $10.47 \pm 0.81$  mg/dl vs.  $10.20 \pm 1.03$  mg/dl,  $P=0.019$ ) and LVEF ( $40.10 \pm 5.40\%$  vs.  $36.04 \pm 5.64\%$ ,  $P<0.0001$ ) were significantly increased after EECP therapy. Also, the mean of systolic ( $112.81 \pm 6.75$  mmHg vs.  $124.27 \pm 9.56$  mmHg,  $P<0.0001$ ) and diastolic ( $71.35 \pm 5.90$  mmHg vs.  $75.52 \pm 5.38$  mmHg,  $P<0.0001$ ) blood pressure were significantly decrease after treatment with EECP. Clinical improvement of chest pain, muscle weakness, dyspnea and daily activity were observed in 14 patients (29.2%), 11 patients (22.9%), 24 patients (50%) and 28 patients (58.3%), respectively. Finally 31 patients (64.6%) were satisfy form this treatment. The complication included low back pain in 6 patients (12.5%) and paresthesia in 4 patients (8.3%).

**Conclusion:** In conclusion, the results of our study show EECP therapy is a safe treatment and can reduced systolic and diastolic blood pressure, increase hemoglobin level and LVEF and improve clinical condition of CAD patients.

**Keywords:** coronary artery disease, enhanced external counter pulsation, left ventricular ejection fraction, clinical parameters, paraclinical parameters

#### Introduction

Coronary artery disease (CAD) is the most common reason of mortality in the world (1). It's estimated nearly one patients in each 30 patients with stable CAD experiencing acute myocardial

infarction (AMI) or cardiovascular death each year (2). CAD can induce chronic myocardial ischemia that causes stable angina and affected the patient's daily activity and their quality of life (3).

Management of CAD could be variable from medical treatment to invasive surgical and non-surgical coronary interventions (4, 5). But there are some patients who aren't response to medical therapy and not suitable for invasive treatment. Therefore, this subgroup of patients need an alternative therapy (5). One of the new alternative treatment that suggested for this patients is enhanced external counter pulsation (EECP) (6). EECP is a non-invasive outpatient therapy and consist of 3 sets of cuffs on the upper thigh, lower thigh and calves of each leg are inflated with compressed air during the diastolic phase of the cardiac cycle and are deflated in early systole (7). The use of EECP is suggested for treatment of chronic angina when the pharmacotherapy was failed and patients weren't suitable for invasive procedure (5, 8). Nevertheless, the role of EECP Still not properly approved. Therefore, we design this study to investigate the clinical and paraclinical effects of EECP therapy in patients with CAD.

#### Materials and methods:

We performed a retrospective analysis of data related to all patients who received EECP treatment at Shafa hospitals in Sari, Iran from 21 March 2013 to 21 March 2015. Our exclusion criteria's were inclusive cardiac arrhythmia, coagulation disorder, deep vein thrombosis, pregnancy, abdominal aortic aneurysm, new AMI, cardiac valvular disorder, CABG within past 3 months, blood pressure greater than 180/110mmHg, percutaneous coronary intervention in past 6 months, anticoagulant therapy with international normalized ratio (INR) 3< and less than 10 -1hr sessions EECP (9).

The therapeutic system of EECP were consist of a treatment table, a control console, an air compressor, and an integrated set of pneumatic cuffs that are positioned on the calves, thighs and upper thighs/buttocks. The cuffs were inflated with compressed air (up to 300 mm Hg) sequentially from distal to proximal in early diastole and rapidly deflated immediately prior to the onset of systole (9). This sequence were sync with cardiac cycle via microprocessor-interpreted electrocardiogram signals.

All patient's data included demographic data, history of underlying disease, clinical sign and

symptom, laboratory data (hemoglobin, triglyceride (TG), cholesterol, Low-density lipoprotein (LDL), High-density lipoprotein (HDL)) and left ventricular ejection fraction (LVEF) in before and after treatment by EECP were collected.

#### Statistical Analysis

Data were analysis by SPSS 18. Patient's characteristics were described using means, standard deviations, and percentages wherever appropriate. We used the chi-square test for comparisons of categorical variables and Student t test for continuous variables. P values < 0.05 were considered statistically significant

#### Results:

This study included 48 patients (include 25 men) with mean age of  $62.20 \pm 10.15$  years. The mean of patient's body mass index (BMI) was  $26.59 \pm 1.77$  kg/m<sup>2</sup>. Based on history, 14 patients had hypertension (29.2%), 25 patients had DM (52.1%), 13 patients had DLP (27.1%), 11 patients had history of MI (22.9%) and 14 patients had history of smoking (29.2%). Also, the evaluation of drug history shown 38 patients (79.2%) used atorvastatin, 38 patients (79.2%) used aspirin, 24 patients (79.2%) used clopidogrel, 11 patients used angiotensin converting enzyme inhibitor (ACE-I), 37 patients (79.2%) used  $\beta$ -blocker, 40 patients (83.3%) used Nitrate and 13 patients (79.2%) used calcium channel blocker.

Patient's blood pressure and paraclinic data, before and after treatment with EECP, were summaries in the table 1. As you can see in this table, the mean of TG, Cholesterol, LDL and HDL were not significantly change after EECP therapy. However, the mean of Hemoglobin ( $10.47 \pm 0.81$ mg/dl vs.  $10.20 \pm 1.03$ mg/dl, P=0.019) and LVEF ( $40.10 \pm 5.40\%$  vs.  $36.04 \pm 5.64\%$ , P<0.0001) were significantly increased after EECP therapy. Also, the mean of systolic ( $112.81 \pm 6.75$ mmHg vs.  $124.27 \pm 9.56$ mmHg, P<0.0001) and diastolic ( $71.35 \pm 5.90$ mmHg vs.  $75.52 \pm 5.38$ mmHg, P<0.0001) blood pressure were significantly decrease after treatment with EECP.

Clinical improvement of chest pain, muscle weakness, dyspnea and daily activity were observed in 14 patients (29.2%), 11 patients (22.9%), 24 patients (50%) and 28 patients

(58.3%), respectively. Finally 31 patients (64.6%) were satisfy form this treatment.

Only two type of minor complication were observed that included low back pain in 6 patients (12.5%) and paresthesia in 4 patients (8.3%).

Table 1. Patient's blood pressure and paraclinic data, before and after treatment with EECP

factors	Before EECP therapy	after EECP therapy	P value
SBP (mmHg)	124.27±9.56	112.81±6.75	P<0.0001
DBP (mmHg)	75.52±5.38	71.35±5.90	P<0.0001
TG (mg/dl)	212.20±60.71	210.31±56.93	P=0.333
Cholesterol (mg/dl)	182.52±38.63	183.08±37.30	P=0.603
LDL (mg/dl)	97.22±30.29	97.35±28.76	P=0.883
HDL (mg/dl)	42.89±5.39	43.66±4.90	P=0.130
Hemoglobin (mg/dl)	10.20±1.03	10.47±0.81	P=0.019
LVEF (%)	36.04±5.64	40.10±5.40	P<0.0001

EECP: enhanced external counter pulsation, SBP: systolic blood pressure, DBP: diastolic blood pressure, TG: triglyceride, LDL: low density lipoprotein, HDL: high density lipoprotein, LVEF: left ventricular ejection fraction

### Discussion

EECP suggested as a one of the alternative treatment in CAD patients who aren't response to medication therapy and their condition aren't suitable for invasive procedure such as PCI, angioplasty or CABG (8, 10). Therefore this study design to assessment the clinical and paraclinical effects of enhanced external counter pulsation therapy in patients with coronary artery disease.

Our results shown that EECP therapy can reduce both SBP and DBP. Same with this results, Dockery et al. in their prospective before and after study and Braith et al. in their randomized sham-controlled study shown EECP therapy can significantly decrease SBP and DBP (10, 11). The previous studies shown sequence of pneumatic cuff inflation and deflation in EECP therapy lead to decrease in systemic vascular resistance, improve endothelial dysfunction and Nitric oxide level (9, 12). Finally these changes can lead to decrease systemic blood pressure.

In this study, the mean of lipid profile included TG, cholesterol, LDL and HDL were not significantly change after EECP therapy. Braith et al. find same

results. In their study, there were not significantly difference observed between two groups(10). It's seems, EECP therapy had not affected TG, cholesterol, LDL and HDL level.

Conditions that decrease in myocardial oxygen supply can lead to ischemia and angina (13). The main factors in oxygen supply are oxygen tension and the hemoglobin concentration that determine oxygen-carrying capacity of the blood (14). In this study the clinical sign and symptom of patients were improved after EECP therapy. Also, the level of hemoglobin and LVEF was significantly increased after EECP. It's seems, increase in hemoglobin level in one hand and improve of cardiac output (LVEF) in other hand were the main reasons of patients clinical improvement. Same with our study, Kozdag et al. and Beck et al. reported that EECP therapy can improve clinical and biochemical parameters in CAD patients (9, 15).

In conclusion, the results of our study show EECP therapy is a safe treatment and can reduced systolic and diastolic blood pressure, increase hemoglobin level and LVEF and improve clinical condition of CAD patients.

### Reference

- Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. *PLoS medicine*. 2006;3(11):e442.
- Steg PG, Bhatt DL, Wilson PW, D'Agostino R, Ohman EM, Röther J, et al. One-year cardiovascular event rates in outpatients with atherothrombosis. *Jama*. 2007;297(11):1197-206.
- Ruparelia N, Kharbanda RK. Role of coronary physiology in the contemporary management of coronary artery disease. *World Journal of Clinical Cases: WJCC*. 2015;3(2):148.
- Petersson T, Bondesson S, Cojocaru D, Ohlsson O, Wackenfors A, Edvinsson L. One year follow-up of patients with refractory angina pectoris treated with enhanced external counterpulsation. *BMC cardiovascular Disorders*. 2006;6(1):28.
- Esmailzadeh M, Khaledifar A, Maleki M, Sadeghpour A, Samiei N, Moladoust H, et al. Evaluation of left ventricular systolic and diastolic regional function after enhanced external counter pulsation therapy using strain rate imaging. *European Journal of Echocardiography*. 2009;10(1):120-6.
- Soran O, Kennard ED, Kfoury AG, Kelsey SF, Investigators I. Two-year clinical outcomes after enhanced external counterpulsation (EECP) therapy in patients with refractory angina pectoris and left ventricular dysfunction (report from The International EECP Patient Registry). *The American journal of cardiology*. 2006;97(1):17-20.

7. Yavari M, Montazeri H. Effects of enhanced external counterpulsation on anginal symptoms and improvements in objective measures of myocardial ischaemia: cardiovascular topic. *Cardiovascular journal of Africa*. 2007;18(3):154-6.
8. Soran O. A new treatment modality in heart failure: enhanced external counterpulsation (EECP). *Cardiology in review*. 2004;12(1):15-20.
9. Beck DT, Martin JS, Casey DP, Avery JC, Sardina PD, Braith RW. Enhanced external counterpulsation improves endothelial function and exercise capacity in patients with ischaemic left ventricular dysfunction. *Clinical and Experimental Pharmacology and Physiology*. 2014;41(9):628-36.
10. Braith RW, Conti CR, Nichols WW, Choi CY, Khuddus MA, Beck DT, et al. Enhanced External Counterpulsation Improves Peripheral Artery Flow-Mediated Dilatation in Patients With Chronic Angina A Randomized Sham-Controlled Study. *Circulation*. 2010;122(16):1612-20.
11. Dockery F, Rajkumar C, Bulpitt CJ, Hall RJ, Bagger JP. Enhanced external counterpulsation does not alter arterial stiffness in patients with angina. *Clinical cardiology*. 2004;27(12):689-92.
12. Eftekhari A, May O. The immediate hemodynamic effects of enhanced external counterpulsation on the left ventricular function. *Scandinavian Cardiovascular Journal*. 2012;46(2):81-6.
13. Juneau M, Johnstone M, Dempsey E, Waters DD. Exercise-induced myocardial ischemia in a cold environment. Effect of antianginal medications. *Circulation*. 1989;79(5):1015-20.
14. Jawad E, Arora R. Chronic stable angina pectoris. *Disease-a-Month*. 2008;54(9):671-89.
15. Kozdağ G, Ertaş G, Aygün F, Emre E, Kirbaş A, Ural D, et al. Clinical effects of enhanced external counterpulsation treatment in patients with ischemic heart failure. *Anadolu Kardiyol Derg*. 2012;12:214-21.