

# EECP Ameliorates Endothelial Dysfunction & Elevates Exercise Tolerance in CAD

Yang H et al. | Front Cardiovasc Med. 2022;9:997109 | PMC9744945

<b>DOI</b>	10.3389/fcvm.2022.997109
<b>Published</b>	29 November 2022
<b>Journal</b>	Frontiers in Cardiovascular Medicine — Open Access, CC BY 4.0
<b>Authors</b>	Huongrui Yang, Lixue Song, Xiang Ning et al.   Second Hospital of Shandong University; Shandong First Medical University
<b>Study Type</b>	Randomised Controlled Trial (RCT) — n=240 patients
<b>Trial Registration</b>	ChiCTR1800020102 (chictr.org.cn)
<b>PMID</b>	36523357
<b>ACC Relevance</b>	Demonstrates EECP rehabilitates peripheral vascular function, VEGF/angiogenesis, and exercise capacity — all key to injury rehab

## Study Design

240 patients with coronary artery disease diagnosed by coronary angiography were randomly divided 1:1 into an EECP group (n=120) and a control group (n=120). The EECP group received 35 one-hour daily sessions over 7 consecutive weeks at cuff inflation pressures of 300 mmHg. The control group received the identical treatment course but at 0–10 mmHg (sham). All patients received standard cardiovascular medications. No adverse cardiovascular events occurred in either group. Follow-up was at 1 year post-treatment.

## Outcome Measures

<b>Haemodynamics</b>	Carotid artery Doppler: PSV, EDV, RI, inner diameter, fluid shear stress (FSS)
<b>Endothelial markers</b>	VEGF, VEGFR2, Angiopoietin-2 (Ang2) by ELISA
<b>Exercise capacity</b>	VO <sub>2</sub> max, metabolic equivalents (METs), anaerobic threshold (AT), exercise load time, O <sub>2</sub> pulse (VO <sub>2</sub> max/HR) — by cardiopulmonary exercise testing

## Key Results

Parameter	EECP Group (Pre → Post)	Control Group (Pre → Post)	Significance
EDV (carotid)	Significantly increased	No significant change	p<0.05
PSV (carotid)	Significantly increased	No significant change	p<0.01
Inner diameter (ID)	Increased	No change	p<0.01
Fluid shear stress (FSS)	Significantly increased	No change	p<0.01
VEGF (serum)	Significantly elevated	Elevated but less	p<0.01 between groups
VEGFR2 (serum)	Significantly elevated	Elevated but less	p<0.01 between groups
Ang2 (serum)	Decreased	No change	p<0.05
Exercise load time	Significantly increased	No change	p<0.001
VO2max	1183→1423 mL/min	1145→1159 mL/min	p<0.001 (EECP)
METs	4.47→5.25	4.53→5.11	p=0.001 (EECP), p<0.001 (control)
AT	31.40→36.25 mL/min/kg	31.32→31.18 mL/min/kg	p<0.001 (EECP only)
VO2max/HR (O2 pulse)	9.93→11.43 mL/beat	10.08→10.38 mL/beat	p<0.001 (EECP only)

## Multivariate Regression Findings

Multiple linear regression confirmed that changes in VEGF (p<0.001) and VEGFR2 (p=0.023) were independent positive predictors of MET improvements. FSS was positively correlated with VEGF (r=0.356, p<0.001) and VEGFR2 (r=0.407, p<0.001). These findings demonstrate that EECP-induced haemodynamic shear stress drives VEGF/VEGFR2 upregulation, which in turn drives angiogenesis and improved exercise capacity. This is the same molecular pathway implicated in fracture healing, tissue repair, and post-injury vascular rehabilitation.

## Conclusions

EECP is a useful therapeutic measurement for the long-term amelioration of endothelial dysfunction and elevation of exercise tolerance in patients with coronary heart disease. The study provides RCT-level evidence for EECP's capacity to improve haemodynamics, angiogenic signalling (VEGF, VEGFR2), and cardiopulmonary function at 1-year follow-up.

## Full Citation

Yang H, Song L, Ning X, Ma Y, Xue A, Zhao H, Du Y, Lu Q, Liu Z, Wang J. Enhanced external counterpulsation ameliorates endothelial dysfunction and elevates exercise tolerance in patients with coronary artery disease. *Front Cardiovasc Med.* 2022 Nov 29;9:997109. doi: 10.3389/fcvm.2022.997109. PMC: PMC9744945. PMID: 36523357.