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Enhanced External Counterpulsation Significantly Improves Angina Frequency in No-Option Patients with Coronary Artery Disease

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Many patients with coronary artery disease (CAD) are not candidates for bypass surgery or angioplasty despite having disabling angina on full antianginal medication. We evaluated the role of enhanced external counterpulsation (EECP), a noninvasive treatment for angina, in these no-option patients at our hospital. Forty-four patients with a mean age (63±8 years), 89% males and 11% females, received EECP therapy since August 2001 at our hospital. The therapy included a one-hour session of EECP daily for 35 days. All the patients had angina (CCS) class II or more despite full medical therapy; 33/44 (75%) had prior MI, 26/44 (59.1%) had previous CABG, 4/44 (9%) had PTCA. All the patients were not candidates for CABG/PTCA due to diffuse distal disease. All the patients were evaluated for angina frequency, nitrate intake, 6-minute walk test and quality of life score of 1–5 before and after completion of EECP therapy. All the patients have shown reduction of more than one class in angina (baseline mean angina class 2.7±0.71, post-EECP angina class 1.15±0.63). Episodes of angina per week were significantly reduced from the pre-EECP value of 5.6±4.3 to the post-EECP value of 0.67±0.8. Nitrate requirement per week decreased from pre-EECP 29±3.3 to post-EECP 0.1±0.3. Overall quality of life score improved from 3.6±0.62 to 1.87±0.34 after EECP. Significant improvement was noted in the 6-minute walk test from pre-EECP 847.1±260 feet to post-EECP 1196±385 feet. It was concluded from our study that EECP is an effective modality of treatment in patients who are no longer suitable candidates for CABG/PTCA despite having limiting angina on full antianginal medications.

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Enhanced External Counterpulsation Therapy Improves Endothelial Function in Patients with Coronary Artey Disease

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Patients with angina have been shown to improve with the non-invasive enhanced external counterpulsation (EECP) therapy, however the mechanism is still uncertain. We assessed the effect of EECP therapy on endothelial function of such patients through estimation of flow- mediated dilation (FMD) of brachial artery. Consecutive patients (n=74, 95% males) with coronary artery disease (CAD) having refractory angina not amenable to revascularization, were subjected to EECP therapy 1-hour daily for 35 days. FMD was assessed at baseline and the day after completion of 35 sittings of EECP therapy. Brachial artery diameter (dia) and flow was measured at rest and 1 min post-release (5 min occlusion by cuff) and compared using student t test. All patients showed more than 1 NYHA class improvement in angina following EECP. Baseline and post- EECP FMD results are shown in the table showing an overall improvement of 26% in FMD after EECP.

	Pre-EECP	Post-EECP	p value
Dia rest (mm)	3.74±0.5	3.9±0.48	<0.001
Dia release (mm)	4.15±0.52	4.41±0.51	<0.001
VTI rest (cm)	10.31±4.6	12.2±5.3	<0.01
VTI release (cm)	49.6±21.6	57.3±27.6	<0.01
Dia change (%)	11.04±5.9	13.9±6.7	<0.001

Dia: brachial artery diameter; VTI: velocity time integral

In conclusion, EECP significantly improves endothelial function as assessed by increase in FMD in patients of refractory angina. This may be responsible for the clinical effects of EECP therapy.

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Sustained Improvement of Angina by Enhanced External Counterpulsation is Predominantly due to its Peripheral Effects

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Enhanced external counterpulsation (EECP) is a noninvasive treatment for angina, the exact mechanism of which is unclear. It could have a central effect by augmenting coronary collateral circulation, or a peripheral training effect on the muscles. We attempted to understand the mechanism of the anti-ischemic effect of EECP by comparing pre- and post- EECP modified Bruce exercise thallium scans (Th scans) in 28 consecutive patients who presented at our center. On Th scan, area of ischemia (Area), and perfusion score (Perf) were compared before and after EECP. All the patients claimed improvement in angina status. There was a statistically significant improvement in mean NYHA class, and 6-min walk distance from pre- to post-EECP, respectively. Nearly 72% of patients showed improvement in exercise duration (E time), 43% had a reduction in Area, and 54% showed improvement in Perf. Changes in the parameters are shown in the table.

Parameter	Pre-EECP	Post-EECP	p value
E time (s)	356±199	429±219	0.013
METS	4.6±2	5.4±2.2	0.009
Double product (10^3)	20.5±4	19±4.5	ns
Area	29.2±20	30.1±21.2	ns
Perf	4.2±6.2	3.75±5	ns

ns: not statistically significant

In patients undergoing EECP, the improvement in symptomatic status and exercise tolerance occurs without altering the double product or perfusion on peak exercise. The training effect thus seems to be the dominant effect of EECP.

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Anti-Anginal Effect of Enhanced External Counterpulsation Persists After Six Months in Patients with Angina

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Enhanced external counterpulsation (EECP) has been recently accepted as a noninvasive treatment for angina, although controversy still persists as to how long the effect lasts after completion of the therapy. We present six-month follow-up data on patients who had undergone EECP therapy at our hospital. Forty-four patients have completed 35 hours of EECP at our hospital from August 2001 till date; 18 patients (mean age 63.5 years, 94% male) have completed 6-month follow-up after EECP. All the patients were assessed for angina status, 6-minute walk distance and quality-of-life score. Of the total, 72% (18/13) of patients had prior CABG, 12% (2) had prior PTCA; 83% had prior MI, the baseline EF was 37%; 83% had TVD and 17% DVD. After completion of EECP therapy, 16 patients (89%) had no angina, 2 (10%) had recurrence of class II angina in six months. Angina could be controlled by altering medication in 1 patient. In the other patient, we had to give one week's reinforcement EECP therapy. Two patients had symptomatic heart failure. Both these patients had severe LV dysfunction (EF 19% and 22%). In both cases, the failure was attributable to dietary irregularities and not to ischemia. Both patients improved by increasing diuretics. There was no significant deterioration in overall angina episodes per week (0.43±0.51 after EECP therapy to 0.60±0.7 at six months). We conclude that beneficial effects of EECP persist at six months of follow-up in most of the patients with coronary artery disease having refractory angina.

Prospective Evaluation of Enhanced External Counter Pulsation in Congestive Heart Failure (PEECH)

Presented at ACC, 2005

Enhanced external counter pulsation (EECP) therapy has previously been shown to be beneficial for patients with chronic stable angina. However, data in patients with heart failure are scarce. The aim of the present trial was to evaluate the role of EECP in patients with stable heart failure with NYHA Class II or III symptoms, ischemic or non-ischemic etiology, left ventricular (LV) ejection fraction <35%, optimal pharmacologic therapy, ability to exercise >3 min, limited by shortness of breath or fatigue (not by angina). Patients were randomized to EECP with optimal pharmacologic therapy (*n*=93) or optimal pharmacologic therapy alone (*n*=94). EECP therapy consists of a series of inflatable cuffs that are rapidly inflated at the onset of diastole and rapidly deflated at the onset of systole in order to replicate the hemodynamic properties of intra-aortic balloon counter pulsation. EECP was administered for 35 sessions of 1-hour each and continued for 7 weeks. Patients underwent exercise stress test at baseline and 3 months. Optimal pharmacologic therapy included angiotensinconverting enzyme (ACE) inhibitors (76%) or angiotensin receptor blockers (ARB)(19%) and beta-blockers (85%). Baseline characteristics were well balanced between treatment groups. Ischemic etiology was present in 69% of patients and 65% were in NYHA class II. Baseline ejection fraction was 26%. Increase in exercise duration by at least 60 s at 6 months occurred more frequently in the EECP group compared with controls (35.4% *v.* 25.3%, p=0.016). There was no difference in the co-primary endpoint of increase in peak VO2 of at least 1.25 ml/min/ kg between groups (22.8% for EECP *v.* 24.1% for control, p=NS). Change in exercise duration was longer in the EECP group compared with control as early as one week (26.4 s increase *v.* 10.0 s decrease, p=0.01) and maintained through 6 months (24.7 s increase *v.* 9.9 s decrease, p=0.01). Improvement in NYHA class was more common in the EECP group compared with controls at 1 week (33.3% *v.* 11.4%, p<0.001) and maintained through 6 months (31.3% *v.* 14.3%, p<0.001). Change from baseline in Minnesota Living with Heart Failure score was greater in the EECP group at 1 week (-8.9 *v.* -3.4, p=0.01) and 3 months (-7.1 *v.* -2.9, p=0.01) but did not differ at 6 months (-3.7 *v.* -2.9, p=NS). Serious adverse events were reported in 30.3% of the EECP group and 29.5% of the control group (p=NS). In conclusion, among patients with systolic dysfunction, stable heart failure symptoms and treated with optimal pharmacologic therapy, use of EECP was associated with improvement in exercise duration, NYHA class and quality of life but no difference in change in peak VO_2 compared with optimal pharmacologic therapy alone.
