Enhanced external counterpulsation and heart failure


Manchanda A, Soran O.

Department of Internal Medicine, The George Washington University, Washington, DC, USA.

Between 25,000 and 75,000 new cases of angina refractory to maximal medical therapy and standard coronary revascularization procedures are diagnosed each year. In addition, heart failure also places an enormous burden on the U.S. health care system, with an estimated economic impact ranging from $20 billion to more than $50 billion per year. The technique of counterpulsation, studied for almost one-half century now, is considered a safe, highly beneficial, low-cost, noninvasive treatment for these angina patients, and now for heart failure patients as well. Recent evidence suggests that enhanced external counterpulsation (EECP) therapy may improve symptoms and decrease long-term morbidity via more than 1 mechanism, including improvement in endothelial function, promotion of collateralization, enhancement of ventricular function, improvement in oxygen consumption (VO2), regression of atherosclerosis, and peripheral training effects similar to exercise. Numerous clinical trials in the last 2 decades have shown EECP therapy to be safe and effective for patients with refractory angina with a clinical response rate averaging 70% to 80%, which is sustained up to 5 years. It is not only safe in patients with coexisting heart failure, but also is shown to improve quality of life and exercise capacity and to improve left ventricular function long-term. Interestingly, EECP therapy has been studied for various potential uses other than heart disease, such as restless leg syndrome, sudden deafness, hepatorenal syndrome, erectile dysfunction, and so on. This review summarizes the current evidence for its use in stable angina and heart failure and its future directions.

PMID: 17936150 [PubMed - indexed for MEDLINE]

The role of enhanced external counterpulsation in the treatment of angina and heart failure.

Arora RR, Shah AG.

Department of Medicine, Chicago Medical School, Chicago, IL 60064, USA. rohit.arora@med.va.gov
As the incidence of angina and heart failure continue to rise, new therapeutic options will be needed to treat patients who remain symptomatic or who are intolerant to current treatment. Enhanced external counterpulsation (EECP) is a noninvasive modality being investigated in both angina and congestive heart failure patients. It has been proven to provide symptomatic benefit in angina patients, but has not been proven to show an increase in life expectancy or decrease in cardiovascular events. EECP in heart failure has been proven to be safe, but its efficacy is still uncertain. The present paper summarizes the current literature on the clinical use of EECP in angina and heart failure.

PMID: 17703254 [PubMed - indexed for MEDLINE]

Enhanced external counterpulsation improves exercise duration and peak oxygen consumption in older patients with heart failure: a subgroup analysis of the PEECH trial.

Abbottsmith CW, Chung ES, Varricchione T, de Lame PA, Silver MA, Francis GS, Feldman AM; Prospective Evaluation of EECP in Congestive Heart Failure Investigators.

The Ohio Heart and Vascular Center, Cincinnati, OH 45219, USA.

The Prospective Evaluation of Enhanced External Counterpulsation in Congestive Heart Failure (PEECH) trial demonstrated that enhanced external counterpulsation (EECP) therapy increased exercise duration and improved functional status and quality of life without affecting peak oxygen consumption. The authors present data from a prespecified subgroup of elderly patients (65 years or older) enrolled in the PEECH trial. The 2 co-primary end points were the percentage of subjects with a >60-second increase in exercise duration and the percentage of subjects with a >1.25-mL/kg/min increase in peak volume of oxygen consumption. At 6-month follow-up, the exercise responder rate was significantly higher in EECP patients compared with controls (P=.008). Further, in contrast to the overall PEECH study, the EECP group demonstrated a significantly higher responder rate for peak oxygen consumption (P=.017). The authors conclude that an older subgroup of PEECH subjects confirms the beneficial effect of EECP in patients with chronic, stable, mild-to-moderate heart failure.

PMID: 17170583 [PubMed - indexed for MEDLINE]

Enhanced external counterpulsation improves exercise tolerance in patients with chronic heart failure.

OBJECTIVES: The PEECH (Prospective Evaluation of Enhanced External Counterpulsation in Congestive Heart Failure) study assessed the benefits of enhanced external counterpulsation (EECP) in the treatment of patients with mild-to-moderate heart failure (HF). BACKGROUND: Enhanced external counterpulsation reduced angina symptoms and extended time to exercise-induced ischemia in patients with coronary artery disease, angina, and normal left ventricular function. A small pilot study and registry analysis suggested benefits in patients with HF. METHODS: We randomized 187 subjects with mild-to-moderate symptoms of HF to either EECP and protocol-defined pharmacologic therapy (PT) or PT alone. Two co-primary end points were pre-defined: the percentage of subjects with a 60 s or more increase in exercise duration and the percentage of subjects with at least 1.25 ml/min/kg increase in peak volume of oxygen uptake (VO2) at 6 months. RESULTS: By the primary intent-to-treat analysis, 35% of subjects in the EECP group and 25% of control subjects increased exercise time by at least 60 s (p = 0.016) at 6 months. However, there was no between-group difference in peak VO2 changes. New York Heart Association (NYHA) functional class improved in the active treatment group at 1 week (p < 0.01), 3 months (p < 0.02), and 6 months (p < 0.01). The Minnesota Living with Heart Failure score improved significantly 1 week (p < 0.02) and 3 months after treatment (p = 0.01). CONCLUSIONS: In this randomized, single-blinded study, EECP improved exercise tolerance, quality of life, and NYHA functional classification without an accompanying increase in peak VO2.

PMID: 16979005 [PubMed - indexed for MEDLINE]


Mechanisms and evidence for the role of enhanced external counterpulsation in heart failure management.

Silver MA.

Advocate Christ Medical Center, Suite 319 South, Oak Lawn, IL 60453, USA.
marc.silver@advocatehealth.com

Balloon counterpulsation has gained widespread acceptance as a therapy for cardiogenic shock. However, over the past four decades a parallel method of noninvasive counterpulsation, enhanced external counterpulsation (EECP), has been defined and developed. Mechanisms of benefit for this technology continue to emerge and include enhanced coronary and other key target organ perfusion beds. Other mechanisms include angiogenesis and enhanced cellular metabolism. Beyond putative mechanisms there is ample evidence for improved and sustained outcomes in patients with and without left ventricular dysfunction. This evidence comes from long-term registry reports and randomized clinical trials. With respect to heart failure (HF), there is registry, pilot trial, and randomized clinical trial evidence of safety and efficacy. This paper summarizes some of the mechanisms and outcomes of EECP in HF patients and helps to elucidate the role of EECP in the management of patients with chronic HF.
Treating heart failure with enhanced external counterpulsation (EECP): design of the Prospective Evaluation of EECP in Heart Failure (PEECH) trial.

Feldman AM, Silver MA, Francis GS, De Lame PA, Parmley WW.

Department of Medicine, Jefferson Medical College, 1025 Walnut Street, Philadelphia, PA 19607, USA.

BACKGROUND: Enhanced external counterpulsation (EECP) treatment can improve exercise tolerance in patients with ischemic heart disease; however, the possible benefits of EECP in patients with stable heart failure (HF) and left ventricular dysfunction (LVD) are unclear. An open pilot study showed significant increases in exercise tolerance in HF patients undergoing EECP. Thus a larger, controlled study of EECP in patients with stable HF (New York Heart Association [NYHA] classes II and III) and LVD was undertaken. METHODS AND RESULTS: The PEECH trial is a controlled, randomized, single-blind, parallel-group, multicenter study of 187 patients with symptomatic but stable HF (NYHA classes II and III) and an LV ejection fraction $\leq 35\%$ was designed to assess the efficiency of EECP in patients with stable HF. Medical therapy is optimized in all patients based on the recommendations of the Heart Failure Society of America ("Usual Care"), and then randomized between 2 treatment groups; UC or EECP (35 hours over 7 weeks). CONCLUSION: Efficacy measures include standard exercise tolerance tests on a treadmill (modified Naughton protocol), with measurements of peak oxygen uptake and exercise duration time; quality of life questionnaires; NYHA classification; and neurohormonal markers of HF.

Angina patients with diastolic versus systolic heart failure demonstrate comparable immediate and one-year benefit from enhanced external counterpulsation.

Lawson WE, Silver MA, Hui JC, Kennard ED, Kelsey SF.

SUNY Stony Brook, Stony Brook, NY 11740, USA.

BACKGROUND: Enhanced external counterpulsation (EECP) is effective in treating angina in coronary artery disease patients. Whether EECP produces similar immediate and sustained benefits and freedom from adverse events (MACE) at 1 year in patients with severe systolic dysfunction versus diastolic dysfunction is unknown. METHODS AND RESULTS: Data of 746 angina patients with a history of heart failure enrolled in the International EECP Registry were divided into 2 groups: left ventricular ejection
fraction (LVEF) ≤35% (S) and LVEF >35% (D). Mean LVEF was 51.0 +/- 10.2% in diastolic dysfunction (n=391) versus 26.3 +/- 6.9% in systolic dysfunction (n=355). At baseline, 92.0% of diastolic dysfunction and 90.9% of systolic had Canadian Cardiovascular Society Class III/IV angina with similar number of anginal episodes and nitroglycerin use. After 32 hours of EECP, angina was reduced by ≥1 class in 71.9% of diastolic versus 72.2% of systolic with similar decreases in anginal episodes and nitroglycerin use. At 1-year 78.1% of diastolic and 75.8% of systolic have less angina than pre-EECP. MACE at 1 year was also comparable (24.4 versus 23.8%).

CONCLUSIONS: The benefits of EECP in heart failure patients were similar regardless of diastolic or systolic dysfunction. The improvement was sustained at 1 year with similar MACE.

PMID: 15704066 [PubMed - indexed for MEDLINE]


**A new treatment modality in heart failure enhanced external counterpulsation (EECP).**

**Soran O.**

Cardiovascular Institute, EECP Research Laboratory, University of Pittsburgh, Pittsburgh, Pennsylvania 15213, USA. soranzo@msx.upmc.edu

Heart failure remains a significant health problem in the United States and in the world. Despite a surfeit of recent diagnostic and therapeutic advances, patients with heart failure remain inadequately helped. The overwhelming need for new and better therapies continues to stimulate scientists to investigate new technologies. Over the past several years the use of enhanced external counterpulsation as a treatment for chronic angina has steadily increased. Recently, its potential role in heart failure management has been shown. We review the role of enhanced external counterpulsation in heart failure management as an emerging noninvasive outpatient therapy.

PMID: 14667258 [PubMed - indexed for MEDLINE]

**Cardiology.** 2001;96(2):78-84.

**Benefit and safety of enhanced external counterpulsation in treating coronary artery disease patients with a history of congestive heart failure.**

**Lawson WE, Kennard ED, Holubkov R, Kelsey SF, Strobeck JE, Soran O, Feldman AM; IEPR investigators.**

SUNY at Stony Brook, NY, USA. wlawson@ts.uh.sunysb.edu

Enhanced external counterpulsation (EECP) is used to noninvasively treat refractory angina patients, including those with a history of heart failure. The International EECP
Patient Registry was used to examine the benefit and safety of EECP treatment, including a 6-month follow-up, in 1,957 patients, 548 with a history of heart failure. The heart failure cohort was older, with more females, a greater duration of coronary artery disease, more prior infarcts and revascularizations. Significantly fewer heart failure patients completed the course of EECP, and exacerbation of heart failure was more frequent, though overall major adverse cardiac events (MACE, i.e. death, myocardial infarction, revascularization) during treatment were not significantly different. The angina class improved in 68%, with comparable quality of life benefit, in the heart failure cohort. At 6 months, patients with congestive heart failure maintained their reduction in angina but were significantly more likely to have experienced a MACE end point. Copyright 2001 S. Karger AG, Basel

PMID: 11740136 [PubMed - indexed for MEDLINE]