Alternative Therapy for Medically Refractory Angina

Enhanced External Counterpulsation and Transmyocardial Laser Revascularization

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KEYWORDS

• Medically refractory angina • Enhanced external counterpulsation therapy • Coronary artery disease • Transmyocardial laser revascularization

KEY POINTS

- Numerous clinical trials in the past 2 decades have shown enhanced external counterpulsation (EECP) therapy to be safe and effective for patients with coronary artery disease (CAD), with a clinical response rate averaging 70% to 80%, which is sustained up to 5 years.
- Benefits associated with EECP therapy include reduction in angina and nitrate use, increased exercise tolerance, favorable psychosocial effects, and enhanced quality of life as well as prolongation of the time to exercise-induced ST-segment depression and an accompanying resolution of myocardial perfusion defects.
- In transmyocardial revascularization (TMR), 20 to 40 transmural channels are created using a high-energy carbon dioxide laser with brief manual compression of the epicardial surface to allow for closure of the epicardial opening sites.
- Studies with TMR have shown an improvement in subjective outcome measures that was counterbalanced by a higher risk of postoperative mortality and morbidity.
- Like TMR, studies with percutaneous transmyocardial laser revascularization (PTMLR) have shown improvement in subjective outcome measures that was counterbalanced by a higher risk of peri- and postmortality and morbidity.

INTRODUCTION

Medically refractory angina pectoris (RAP) is a significant health problem in the United States and worldwide and is defined by presence of severe angina with objective evidence of ischemia and failure to relieve symptoms with coronary revascularization. Before diagnosing a patient with RAP, repeated attempts at "maximizing" medical treatment and lifestyle modification (initiation an exercise program and discontinuation of tobacco) should be made. Additionally, all secondary causes of angina, such as anemia and uncontrolled hypertension, should be excluded.[1]

Based on the 2013 American Heart Association (AHA) statistical update, an estimated 15.4 million Americans greater than or equal to 20 years of age have CAD. Total CAD prevalence is 6.4% in US adults greater than or equal to 20 years of age. CAD makes up more than half of all cardiovascular events in men and women less than 75 years of age. The angina prevalence is 7,800,000 in US adults greater than or equal to 20 years of age.[2] Although not included in the 2013 AHA statistical

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update, it is estimated that between 600,000 and 1.8 million patients in the United States have RAP, with as many as 75,000 new cases diagnosed each year.[3]

Medication and invasive revascularization are the most common approaches for treating CAD. Invasive revascularization includes percutaneous coronary interventions (PCIs)—coronary stent implantation and balloon angioplasty—and coronary artery bypass surgery (CABG). Even though both treatment options are commonly used, neither of these approaches provides a cure. Although the symptoms are eliminated or alleviated, the disease and its causes are still present after treatment. Both treatments target lesions that cause the obstructions; however, CAD is a progressive disease. New treatment approaches are in need to prevent the disease from progressing and the symptoms from recurring.

Current nonpharmacologic options for patients with RAP include neurostimulation (transcutaneous electrical nerve stimulation and spinal cord stimulation), EECP therapy, and laser revascularization. Extracorporeal shockwave myocardial revascularization, gene therapy, and percutaneous in situ coronary venous arterialization are still under investigation. This article summarizes the current evidence for using EECP therapy and TMR in RAP management.[4]

EECP THERAPY

EECP therapy with its different mode of action provides a new treatment modality in the management of CAD and can complement invasive revascularization procedures (**Fig. 1**).[4]

Fig. 1. EECP therapy, consisting of a patient bed attached to an air compressor unit, computerized control console, and 3 sets of cuffs wrapped around the lower legs and the buttocks of the patient. (*Courtesy of* Vasomedical Inc, Westbury, NY; with permission.)

EECP therapy consists of a treatment bed attached to an air compressor unit that is attached to a computerized control console. Three sets of cuffs are wrapped around the lower legs and the buttocks of the patient. It is a noninvasive outpatient therapy consisting of ECG-gated sequential leg compression, which produces hemodynamic effects similar to those of an intra-aortic balloon pump (IABP) (**Fig. 2**).[4]

Unlike IABP therapy, however, EECP therapy also increases venous return. Cuffs resembling oversized blood pressure cuffs—on the calves and lower and upper thighs, including the buttocks—inflate rapidly and sequentially via computer-interpreted ECG signals, starting from the calves and proceeding upward to the buttocks during the resting phase of each heartbeat (diastole). This creates a strong retrograde counterpulse in the arterial system, forcing freshly oxygenated blood toward the heart and coronary arteries while increasing the volume of venous blood return to the heart under increased pressure. Just before the next heartbeat, before systole, all 3 cuffs deflate simultaneously, significantly reducing the heart's workload. This is achieved because the vascular beds in the lower extremities are relatively empty when the cuffs are deflated, significantly lowering the resistance to blood ejected by the heart and reducing the amount of work the heart must do to pump oxygenated blood to the rest of the body. A finger plethysmogram is used throughout treatment to monitor diastolic and systolic pressure waveforms. The current EECP device can generate external cuff pressures as high as 220 to 300 mm Hg. A typical therapy course consists of 35 treatments administered for 1 hour a day over 7 weeks.[4]

Acute hemodynamic effects of EECP have been shown through both noninvasive and invasive studies.[5–10]

Acute hemodynamic effects of EECP are summarized (**Fig. 3**)[4]:

1. Increased retrograde aortic blood flow; diastolic augmentation
2. Increased coronary blood flow; increased perfusion pressure
3. Increased venous return
4. Increased cardiac output
5. Systolic unloading
6. Decreased left ventricular workload

EECP THERAPY IN RAP MANAGEMENT

Numerous clinical trials over the past decade have shown EECP therapy safe and effective for patients with RAP, with a clinical response