Enhanced External Counterpulsation (EECP) for the treatment of Exercise Fatigue and Traumatic Sports Injuries.

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Abstract

Background – EECP is currently approved for the treatment of Angina Pectoris, but anecdotal evidence suggests that EECP may be effective in the treatment of Exercise Fatigue and Traumatic Sports Injuries as well. (1)The postulated mechanism of action includes central and peripheral components that include reducing cardiac demand to accelerate recovery, and increasing microcirculation to enhance healing and reduce the buildup of lactic acid.

Methods – A case series of 21 professional athletes. Four athletes had previously sustained serious injuries, seven athletes had sustained minor injuries, and ten athletes were healthy. All of the subjects were at risk for Exercise Fatigue. Subjects underwent EECP treatments and underwent objective and subjective serial evaluations including range of motion, girth of injured limb (as an indicator of post-injury swelling), pain scale, and muscle tightness scale.

Results - The four subjects who had recently sustained relatively serious injuries all showed decreases in girth of the affected limb (-1 to –7cm) and 3 out of 4 subjects demonstrated increases in range of motion (+6 to +16 degrees). Pain scale measurements showed a wide variation (range 0 to –6) and the muscular tightness scale showed a decrease (-2.5 after 15 treatments and -2 after 3 treatments) for 2 subjects and no change for 2 subjects. The seven subjects who had recently sustained minor injuries all demonstrated decreases in their pain scores (range 1 to 8, average =5). All subjects in this subgroup did show a decrease in their muscular tightness scores ranging from 1 to 3 with an average of 2. Nine of the ten healthy subjects reported decreases in their muscular tightness scores (range 1 to 4, average =2).

Adverse Events – None reported

Conclusion – This case series showed improvement in objective and subjective outcomes across each subject group. Overall EECP appears to be a safe and somewhat effective means to decrease pain, decrease swelling, increase range of motion, and potentially increase athletic performance by decreasing muscle tightness and accelerating recovery from Exercise Fatigue.

Introduction

Enhanced External Counterpulsation (EECP) is an FDA approved non-invasive procedure for the treatment of angina pectoris. EECP involves sequential inflation and deflation of compressive cuffs wrapped around the patient's calves, lower thighs, and upper thighs. Inflation and deflation of the cuffs are activated by events in the cardiac

cycle via microprocessor interpreted ECG signal. During diastole, the cuffs inflate distal to proximal which raises aortic pressure and increases coronary perfusion. At the same time, venous return is significantly increased through compression of the venous network in the lower extremities. During systole, rapid decompression of the cuffs produces significant left ventricular unloading with a decrease in cardiac afterload. The combined effects of increased preload, increased coronary perfusion pressure, and decreased afterload result in increased cardiac output with reduced myocardial oxygen demand. (2)

EECP is currently approved for the treatment of angina pectoris,(3) but several researchers have begun to explore the use of EECP for other indications including the treatment of exhaustive athletic training and over training known as Exercise Fatigue. Exercise Fatigue is significant because it increases the likelihood of athletic injury, especially in elite or professional athletes. The theory behind central Exercise Fatigue treatment with EECP involves reducing cardiac oxygen demand during rest to accelerate cardiac muscle recovery. In addition, peripheral Exercise Fatigue treatment occurs by the enhancement of local arterial, venous, and lymphatic circulation that occurs with compression of the lower extremities and serves to enhance muscular microcirculation to accelerate tissue repair and to decrease lactic acid buildup. This will likely decrease local edema as well as muscular pain and stiffness.

To date there have not been any studies evaluating the use of EECP in treating Exercise Fatigue. We have constructed a case series of 21 professional athletes (arena football players from the LA Avengers) who are either healthy, but at risk for Exercise Fatigue, or have already been injured.

Methods

Study Design - This was a case series of 21 male professional football players who underwent several EECP treatments to treat a specific injury or to improve athletic ability. Subjects were recruited by the athletic trainer of the LA Avengers (an arena football team). Four subjects had traumatic injuries, seven subjects had minor injuries, and ten subjects had no injuries. Subjects were treated with EECP between 2 and 17 times (average = 4.7 treatments).

Outcomes - The primary outcome for the traumatically injured patients was pre and post treatment girth (as a marker of traumatic swelling) and range of motion (ROM). The primary outcome for the healthy subjects was subjective muscle tightness. The primary outcome for the subjects with minor injuries was a pre and post treatment subjective pain scale and the muscle tightness scale was used as a secondary outcome.

Girth was measured at four standardized locations (patella at the midline of the patella, Quadriceps at 4" above the superior pole of the patella, Calf at 4" below the inferior pole of the patella, and Achilles tendon at 1" above the lateral malleolus). Range of motion was measured using a goniometer. Pain was assessed using a standardized previously validated 10-point visual analog pain scale. Muscular tightness was measured using a 5-point visual analog scale.

Results

Characteristics of the patients - Traumatic Injury Patients – 2 patients injured their right knee, one patient injured both knees, and one patient tore their right Achilles tendon.

R.S-Right Achilles tendon tear/ April 2001/EECP started on 6/27/01
V.A-Right knee surgery/Beginning on June/EECP started on 6/26/01
C.B-Right knee surgery/April 25th 2001 /EECP started on 6/26/01
K.J-Right Hamstring, left gad, left and right knee, left and right ankle, right calf/May 2001/EECP started on 6/27/01

The four subjects who had recently sustained relatively serious injuries all showed decreases in girth of the affected limb (-1 to –7cm) and 3 out of 4 subjects demonstrated increases in range of motion (+6 to +16 degrees). The fourth subject showed a 1cm decrease in the range of motion at the injured joint. Pain scale measurements showed a wide variation ranging from 0 to –6, which did not vary, by the number of treatments received. The muscular tightness scale showed a decrease (-2.5 after 15 treatments and -2 after 3 treatments) for 2 subjects and no change for 2 subjects.

Table 1 - Subjects who recently sustained relatively serious athletic injuries

V.A.
2 treatments, dates 6/26/01 & 6/28/01
Area of injury: Right knee

Girth measurement	PRE	POST	Results
Right patella	47.0cm	46.0cm	-1.0cm
Right quad	52.0cm	50.0cm	-2.0cm
Right calf	41.0cm	40.0cm	-1.0cm
PROM	PRE	POST	Results
Right knee flexion:	118.0 degree	125.0 degree	+7.0 degree

C.B.
2 treatments, dates 6/27/01 & 6/28/01
Area of injury: Right knee

Girth measurement	PRE	POST	Results
Right patella	46.0cm	46.0cm	0.0cm
Right quad	53.0cm	50.0cm	-3.0cm
Right calf	42.0cm	41.0cm	-1.0cm
PROM	PRE	POST	Results
Right knee flexion:	110.0 degree	109.0 degree	-1.0 degree

R.S.
15 treatments, dates 6/27/01 to 7/17/01
Area of injury: Right Achilles tendon tear
Girth measurement
Right Lateral Malleolus

	PRE	POST	Result
1" above	32.0cm	32.0cm	0.0cm

5"	25.5cm	24.0cm	-1.5cm
10"	33.0cm	32.0cm	-1.0cm
15"	42.0cm	40.0cm	-2.0cm
PROM	PRE	POST	Results
Right plantar flexion	18.0 degree	25.0 degree	+7.0 degree
Right dorsi flexion	+4.0 degree	-12.0 degree	+16.0 degree

K.A.
3 treatments, 6/27/02 & 6/28/01 & 6/29/01
Area of injury: Right and Left knee

Girth measurement	PRE	POST	Results
Right patella	46.5cm	45.0cm	-1.5cm
Right quad	59.0cm	52.0cm	-7.0cm
Right calf	42.5cm	41.0cm	-1.5cm
Left patella	45.0cm	45.0cm	0.0cm
Left quad	56.0cm	55.0cm	-1.0cm
Left calf	42.0cm	40.0cm	-2.0cm
PROM	PRE	POST	Results
Right plantar flexion	124.0 degree	132.0 degree	+8.0cm
Left plantar flexion	120.0 degree	126.0 degree	+6.0cm

MEASURMENT QUIDELINES OF PATELLA
Patella-midline of patella
Quad- 4" above superior pole of patella
Calf-4 " below inferior pole of patella

The seven subjects who had recently sustained minor injuries all demonstrated decreases in their pain scores (range 1 to 8, average =5). The number of treatments (ranging from 2 to 17) did not directly correlate with the decrease in pain. All subjects in this subgroup did show a decrease in their muscular tightness scores ranging from 1 to 3 with an average of 2.

Table 2 - Subjects with minor athletic injuries

Name	# treatments	pre-pain	post-pain	pre-tightness	post-tightness	location of pain
V.H.	9	10	4	4	2	back pain
D.H.	9	6	0	3	1	right knee
C.F.	4	5	2	4	2.5	right hamstring
A.D.	2	10	2	4	1	back pain
P.T.	4	6	5	4	3	right knee
B.R.	2	8	2	3	2	left hip
B.M.	17	5	0	3	0	left ankle
Averages	**6.7**	**7.1**	**2.1**	**3.5**	**1.6**	

Nine of the ten healthy subjects reported decreases in their muscular tightness scores (range 1 to 4, average =2). One subject showed no improvement and no subjects showed any worsening.

Table 3 – Healthy Subjects

Name	# treatments	pre-tightness	post-tightness
C.P	2	4	2.5
C.J.	3	4	2
D.H.	3	3	3
T.H.	3	3	1.5
A.R.	14	3	1
B.C.	2	3	2
K.S.	3	3	2
S.C.	1	4	1
M.H.	1	4	0
M.R.	1	3	1
Averages	**3.3**	**3.4**	**1.6**

Adverse Events

There were no reported adverse events during or after any of the treatments. The only negative outcome occurred in a single subject who demonstrated a 1-degree decrease in range of motion in right knee flexion.

Discussion

This case series demonstrates that the overwhelming majority of subjects reported decreases in their subjective muscle tightness scores. This is relevant as muscle tightness is felt to be a marker for Exercise Fatigue, which can limit an athlete's ability to train and perform and may predispose them to injury. In addition, all previously injured subjects except one reported decreases in their visual analog pain scales. Those four subjects who had sustained the most serious injuries all showed decreases in swelling as measured by girth of the injured limb. Three of the four subjects also demonstrated increases in range of motion of the affected joint.

Each of the measured outcomes showed improvement across each subject group. Overall EECP appears to be a safe and somewhat effective means to decrease pain, decrease swelling, increase range of motion, and potentially increase athletic performance by decreasing muscle tightness. This study is obviously a preliminary step and further studies are required to rigorously test each of the hypotheses stated here. In addition, it would be necessary to compare EECP with a control group who receives only standard interventions after injury (Rest, Ice, Compression, Elevation). It would also be scientifically satisfying to compare EECP with a group of subjects who receive mechanical compression to the lower extremities without the benefit of the cardiac aspects of EECP in order to discern which positive effects are due to compression and which effects are due to increased coronary perfusion and total body circulation.