LOWER LIMB EDEMA

ABSTRACT 2a

Recent studies have indicated that plantar-based vibration may be an effective approach for the prevention and treatment of osteoporosis. We addressed the hypothesis of whether the plantar vibration operated by way of the skeletal muscle pump, resulting in enhanced blood and fluid flow to the lower body. We combined plantar stimulation with upright tilt table testing in 18 women aged 46-63 yr. We used strain-gauge plethysmography to measure calf blood flow, venous capacitance, and the microvascular filtration relation, as well as impedance plethysmography to examine changes in leg, splanchnic, and thoracic blood flow while supine at a 35 degrees upright tilt. A vibrating platform was placed on the footboard of a tilt table, and measurements were made at 0, 15, and 45 Hz with an amplitude of 0.2 g point to point, presented in random order. Impedance-measured supine blood flows were significantly ($P = 0.05$) increased in the calf (30%), pelvic (26%), and thoracic regions (20%) by plantar vibration at 45 Hz. Moreover, the 25-35% decreases in calf and pelvic blood flows associated with upright tilt were reversed by plantar vibration, and the decrease in thoracic blood flow was significantly attenuated. Strain-gauge measurements showed an attenuation of upright calf blood flow. In addition, the microvascular filtration relation was shifted with vibration, producing a pronounced increase in the threshold for edema, P(i), due to enhanced lymphatic flow. Supine values for P(i) increased from 24 +/- 2 mmHg at 0 Hz to 27 +/- 3 mmHg at 15 Hz, and finally to 31 +/- 2 mmHg at 45 Hz ($P < 0.01$). Upright values for P(i) increased from 25 +/- 3 mmHg at 0 Hz, to 28 +/- 4 mmHg at 15 Hz, and finally to 35 +/- 4 mmHg at 45 Hz.

The results suggest that plantar vibration serves to significantly enhance peripheral and systemic blood flow, peripheral lymphatic flow, and venous drainage, which may account for the apparent ability of such stimuli to influence bone mass.

Stewart, Julian M., et al. "Plantar vibration improves leg fluid flow in perimenopausal women." Am J Physiol Regul Integr Comp Physiol 288.3 (2005): R623-R629.

ABSTRACT 2b

BACKGROUND: Peripheral edema (PE) is commonly coupled with heart failure, restrictive cardiomyopathy, nephrotic syndrome, renal failure, and hypoproteinemia. Diuretics and/or limb elevation, although commonly prescribed to treat PE, are often insufficient to remove sufficient fluid to prevent complications. We assessed the ability of the calf muscle pump (CMP) stimulation to reverse PE.

METHODS:
Fluid volume was evaluated by air plethysmography in the right legs of 54 adult women (mean age 46.7 +/- 1.5 years) following venous status assessment. Change in calf volume was assessed during 30 minutes of quiet sitting, followed by 30 minutes of sitting with CMP stimulation via micromechanical stimulation of the plantar surface.

RESULTS:
Leg volume changes demonstrated a bimodal distribution. Leg volume decreased during quiet sitting in 56% of the study group, whereas in 44% of the group, significant lower leg fluid pooling was evident (increase in calf volume of 14.0 +/- 0.3 mL/h). CMP stimulation reversed the fluid pooling in the edematous group (-2.7 +/- 0.1 mL/h) and was able to accelerate fluid removal in the nonedematous group.

CONCLUSIONS:
Approximately two fifths of adult women experience substantial pooling when their lower limbs are maintained in a dependent position. **Lower-extremity edema exhibited by these women may primarily be due to inadequate calf muscle tone because exogenous stimulation of the CMP was sufficient to halt and reverse fluid pooling.** Whether CMP stimulation would provide a means to treat PE in individuals with edema-related health complications, such as congestive heart failure, merits further investigation.

Goddard, Ayana. A., et al. (2008). "Reversal of lower limb edema by calf muscle pump stimulation." J Cardiopulm Rehabil Prev 28(3): 174-179.