LETTER

KAATSU: Rationale for application in Astronauts

Loenneke J P and Pujol T J

Southeast Missouri State University: Department of Health, Human Performance and Recreation, Missouri, USA

Key Words: blood occlusion, hypertrophy, LBNP, anti-gravity, atrophy

Corresponding author: Jeremy P Loenneke, Southeast Missouri State University: Department of Health, Human Performance and Recreation, One University Plaza, Cape Girardeau, MO 63701, Telephone: (573) 651-2197, Fax: (573) 651-5150, e-mail: jploenneke1s@semo.edu

Dear Editor:

Skeletal muscle atrophy and cardiovascular deconditioning associated with space flight is continually observed despite astronauts engaging in both aerobic and resistance exercise[1]. Trappe et al[1] state that perhaps the exercise intensity currently used is not high enough to elicit beneficial effects, concluding a need for more exercise equipment on board allowing for greater resistance and/or a more effective exercise prescription. We believe KAATSU, or blood flow restriction combined with exercise could offer a low load/low intensity alternative to increased resistance.

KAATSU offers a mode of training that could increase the effectiveness of training without increasing the amount of equipment on board, resulting in no additional payload. Two reviews have discussed the mechanisms and benefits of KAATSU training[2,3] and one[2] postulates that KAATSU may benefit astronauts. KAATSU increases muscle hypertrophy at low intensities and may help prevent the cardiovascular deconditioning associated with spaceflight[4]. KAATSU applied to the astronauts' current, low to moderate intensity exercise protocol, may increase the effectiveness of the exercise by combating both skeletal muscle atrophy and cardiovascular deconditioning.

Exercise aboard the space station is largely completed on treadmills[1]. Treadmill walking in full gravity settings at low intensities with moderate blood flow restriction has resulted in muscle hypertrophy in only three weeks[5]. That particular protocol called for treadmill walking for five 2-minute bouts, with 1-minute rest between sets, twice daily. Treadmill speed was 50 m/min and the pressure applied to the proximal portion of the lower leg was 200mmHg. Despite the low intensity of the exercise session, muscle cross sectional area (CSA) and strength were increased. This is significant as one of the concerns highlighted by Trappe et al[1] was the amount of time required and lack of sufficient resistance. Thus, KAATSU walking may provide a mode of exercise that could prevent muscle atrophy allowing for longer duration spaceflight.

Cardiovascular deconditioning is another concern with space flight. Nakajima et al[4] cite hypovolemia, decreased baroreflex responsiveness, and decreased skeletal muscle stiffness as mechanisms responsible for the adverse effects. Currently, lower body negative pressure (LBNP) is used to provide an orthostatic stimulus that attenuates the loss in cardiovascular conditioning. However, LBNP involves using a large-scale apparatus in addition to an exercise machine. LBNP can only be used with a treadmill and/or non resistance-type machines. The novelty of KAATSU is it has recently been shown to induce a LBNP stimulus, meaning it could potentially serve to combat muscle atrophy and cardiovascular deconditioning[4]. Unlike the LBNP apparatuses currently used, KAATSU can be applied to all exercise modes, including treadmills, ergometers, and resistance machines which are all available to astronauts in space.

In closing, KAATSU has demonstrated beneficial adaptations in a variety of populations with no more side effects than traditional exercise[2,3]. Despite this, to our knowledge no studies have investigated the effects of KAATSU in astronauts. We feel the negative effects of spaceflight on skeletal muscle in particular, warrants further investigation into what effects, if any, KAATSU would have on attenuating the loss in skeletal muscle mass and cardiovascular integrity.

References

1. Trappe S, Costill D, Gallagher P, Creer A, Peters J, Evans H, et al. Exercise in space: human skeletal muscle after 6 months aboard the International Space Station. J Appl Physiol. 2009; 106: 1159-1168.
2. Loenneke JP, Pujol T. The use of occlusion training to produce muscle hypertrophy. J Strength Cond. 2009; 31: 77-84.
3. Loenneke JP, Wilson G,Wilson J. A mechanistic approach to blood flow occlusion. Int J Sport Med. 2010; 31: 1-4.
4. Nakajima T, Iida H, Kurano M, Takano H, Morita T, Meguro K, et al. Hemodynamic responses to simulated weightlessness of 24-h head-down bed rest and KAATSU blood flow restriction. Eur J Appl Physiol. 2008; 104: 727-737.
5. Abe T, Kearns C, Sato Y. Muscle size and strength are increased following walk training with restricted venous blood flow from the leg muscle, Kaatsu-walk training. J Appl Physiol. 2006; 100: 1460-1466.