Paper ID: 26443
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SPACE LIFE SCIENCES SYMPOSIUM (A1)
Human Physiology in Space (2)

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ELECTRICAL MUSCLE STIMULATION AND/OR DYNAMIC FLUID FLOW LOADING - EFFECTIVE COUNTERMEASURE ON ATTENUATION OF MUSCULOSKELETAL LOSS

Abstract

Load-induced intramedullary pressure (ImP) is suggested to influence the mechanotransductory signals within bones. Muscle compressions may increase vessel pressure gradient that can directly increase ImP. The aim of this study was to evaluate and compare the effects of electrical muscle stimulation (MS) and dynamic hydraulic flow stimulation (DHS) in a rat functional disuse model. For MS, 6-months-old female Sprague-Dawley retired breeder rats were divided to groups with n=8: 1) baseline, 2) age-matched, 3) hindlimb suspended (HLS), 4) HLS+1 Hz, 5) HLS+20 Hz, 6) HLS+50 Hz, and 7) HLS+100 Hz. For DHS, 5-month-old female Sprague-Dawley virgin rats were assigned to 5 groups (n=10 15): 1) baseline, 2) age-matched, 3) HLS, 4) HLS+static; 5) HLS+DHS. Stimulations were given to right quadriceps (MS) and over the right tibiae (DHS) of the experimental rats for 10min/day (MS) and 10min on-5min off-10min on/day (DHS), 5days/week for 4-weeks. Trabecular bone samples were scanned for using a microCT. Right quadriceps, soleus and gastrocnemius were analyzed in histology. HLS for 4-week significantly reduced trabecular bone quantity and quality. Trabecular BV/TV in MS stimulated animals, expect for 1Hz, was significantly greater than that of disused bone. Animals with MS at 20Hz and 50Hz showed an increase in BV/TV by 143Strong bone loss mitigation effect and skeletal improvement were observed in response to both MS and DHS in the functional disuse model. However, the reverse of muscle atrophy was only observed with 50Hz of MS treatment but not with DHS treatment, indicating that DHS provides a relatively passive stimulation on muscle compared to MS, and was insufficient to reduce muscle atrophy. Moreover, as a relatively more active stimulation, MS was only effective at certain optimal loading condition. The DHS loading parameters may be suitable for bone cell but not for muscle responses. (Supported by NSBRI, and NIH.)