2-2022

Gender-Specific Effects on Muscle Activation During Incline Treadmill Walking: A Virtual Perturbation Study For Future Astronauts

Jie Hao

Robin High

Ka-Chun Siu

GENDER-SPECIFIC EFFECTS ON MUSCLE ACTIVATION DURING INCLINE TREADMILL WALKING: A VIRTUAL PERTURBATION STUDY FOR FUTURE ASTRONAUTS

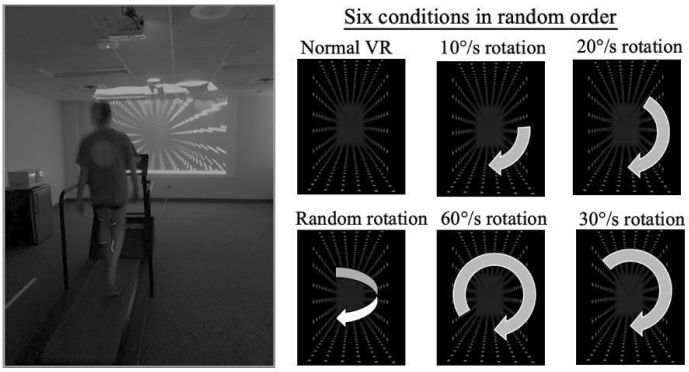
Jie Hao[1*], Robin High[2], and Ka-Chun Siu[1*]
[1]Division of Physical Therapy Education, College of Allied Health Professions, University of Nebraska Medical Center, Omaha, United States, and [2]Department of Biostatistics, College of Public Health, University of Nebraska Medical Center, Omaha, United States. *jie.hao@unmc.edu; kcsiu@unmc.edu

INTRODUCTION

Microgravity-induced muscle atrophy is a critical issue for astronauts in spaceflight [1]. To overcome neuromuscular deconditioning, combining virtual reality (VR) with treadmill training protocol could be a promising countermeasure for astronauts to enhance muscle activities and maximize the training effect [2]. Our previous study [3] found the presence of visual perturbation significantly increased muscle activation while walking on incline treadmill, compared with no visual perturbation; surprisingly, we found females had more pronounced muscle responses than males. Based upon these findings, this study aimed to investigate the effects of different visual rotation speeds and different types of visual perturbation on muscle activation during incline treadmill walking, and how those effects were different between males and females.

METHODS

A total of 20 healthy young adults (10 males and 10 females) participated this study. The normal VR scene was a virtual moving corridor, and its direction and speed were in accordance with the walking speed of the participant on the 9-degree incline treadmill; the participant would feel like walking through an endless corridor. Visual perturbation was created by adding clockwise rotation of the VR in constant or random angular speed. For the constant speed rotation, there were four different rotation speeds at 10°/s, 20°/s, 30°/s, and 60°/s respectively. For the random speed rotation, the rotation speed would change every 360° and was randomly selected at the range of 10°/s and 60°/s. The participant walked in each condition for two minutes. The wireless electromyography sensors were placed at the vastus lateralis (VL), medial hamstring (MH), tibialis anteriors (TA) and lateral gastrocnemius (LG) of the right leg. Multivariate Analysis of Variance (MANOVA) was applied, with the RMS values of VL, MH, TA and LG as the four dependent variables. The analysis was conducted separately for the total gait cycle, and during stance phase and swing phase.



RESULTS

Increased visual rotation speed of visual perturbation induced higher VL and LG activation; gender had different responses to increased visual rotation speed in VL. The effect of different types of visual perturbation was more pronounced in female, as random speed rotation visual perturbation induced higher MH activation than not only normal VR but also constant speed rotation visual perturbation.

CONCLUSION

Integrating visual perturbation into regular treadmill exercise could magnify the training effects to reduce muscle deconditioning for astronauts during spaceflight. The visual rotation speed of visual perturbation should be taken into consideration based on the expected outcome of training. The gender effects revealed different muscle responses between males and females to visual perturbation, which need to be considered and furtherly explored to identify the optimal training countermeasure for astronauts.

REFERENCE

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