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A comment on postural stability improvement in older adults with high fall risk after anodal tDCS on primary motor cortex versus cerebellar stimulation

Dear Editor:

The paper by Yosephi et al. titled *Multiple-session anodal transcranial direct current stimulation (tDCS) enhances the effects of postural training on balance and postural stability in older adults with high fall risk: primary motor cortex versus cerebellar stimulation* generates much interest [1]. Their findings revealed positive treatment effects of both anodal tDCS protocols coupled with postural training on postural stability as compared to sham conditions. Further, the improvements in postural control were greater in the bilateral cerebellar anodal tDCS protocol than the unilateral anodal tDCS on the M1 of dominant hemisphere protocol. These findings are important for clinicians as well as rehabilitation researchers because current evidence indicates that the cerebellum is a potential neuromodulation target for improving postural control in older adults. Despite convincing results and meaningful suggestions made by Yosephi and colleagues, we have several comments regarding the conclusion(s) of their study.

One critical finding in this study was the superior postural stability improvements found after bilateral cerebellar anodal tDCS in comparison to dominant M1 anodal tDCS. Specifically, these stability improvements may be attributed to a less important role of the prefrontal, motor cortex and the posterior parietal lobe in postural control as compared with cerebellar and subcortical regions. However, this proposition should be interpreted cautiously because of an imperfect stimulation location. The targeted region (i.e., C3) of the dominant M1 for the unilateral anodal tDCS protocol is less than ideal for directly modulating brain activation related to postural control. The authors mentioned the possibility that the traditional large tDCS electrodes (i.e., 5×7 cm^2) over C3 influenced some parts of the leg areas adjacent to the arm areas of M1. However, the somatotopy literature states that C3 and C4 in the International 10–20 system are used for the representation areas of the upper extremities whereas Cz is a more precise location for leg representation areas including the hip, leg, foot, toes, and trunk [2,3]. Previous studies reported that the anodal tDCS increased cortical excitability in these leg areas of M1 was highly associated with successful postural control in healthy adults [4,5] as well as in patients with neurological diseases [6]. Presumably, higher cortical activation in the leg areas of M1 facilitated the excitability of spinal neuronal circuits contributing to improved postural control [7]. Thus, a direct comparison of the effects of anodal tDCS on the leg areas of M1 with bilateral cerebellar tDCS is necessary to consolidate the authors' conclusion.

Moreover, recent brain imaging findings identified higher cortical activation across the (a) bilateral side of sensorimotor cortex, (b) cingulate motor areas, and (c) caudate nuclei while post stroke individuals performed improved lower limb movements [8,9]. These findings support the proposition that stimulating the bilateral leg areas of M1 effectively improves various functions of bimanual lower limb movements such as walking, balance, and postural control. In addition, given that the leg areas of M1 are located close to the midline folding into the medial longitudinal fissure [10], applying specialized tDCS techniques (e.g., high-definition tDCS) that can stimulate the precise focal leg representation areas of M1 as well as the deep brain structure may increase postural stability benefits. Taken together, investigating the positive effects of anodal tDCS that preciously modulates the bilateral leg areas of M1 can increase our understanding regarding the role of cerebral regions during postural control.

In summary, we strongly agree with the potential benefits of bilateral cerebellar tDCS on postural control in older adults who exhibit a high risk of falling. Moreover, we support the postulate that the cerebellum is an important recipient of non-invasive brain stimulation. However, we argue that the contribution of cerebral regions for postural control needs to be further investigated using precise and focal targeted areas directly related to lower limb functions for tDCS protocols.

Conflicts of interest

The authors declare that there are no conflict of interest.

Disclosure statement

The authors indicate no financial support.

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Nyeonju Kang
Neuromechanical Rehabilitation Research Laboratory, United States

Division of Sport Science & Sport Science Institute, Incheon National University, Incheon, South Korea

Motor Behavior Laboratory, University of Florida, Gainesville, FL, USA

James H. Cauraugh*
Motor Behavior Laboratory, University of Florida, Gainesville, FL, USA

* Corresponding author. Motor Behavior Laboratory, Department of Applied Physiology and Kinesiology, University of Florida, Gainesville, FL, 32611-8206, USA.
E-mail address: cauraugh@ufl.edu (J.H. Cauraugh).

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