


Special Issue of New Trends in Neuromechanics and Motor Rehabilitation

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1. Introduction

Neuromechanics has been focused on to investigate both behavioral characteristics and underlying neurophysiological mechanisms for various population, including healthy adults, elderly people, and patients with musculoskeletal and neurological diseases [1]. Moreover, based on cross-sectional findings, researchers can develop new rehabilitation programs that effectively improve behavioral and neurophysiological functions in the motor system. These efforts enable us to identify new neuromechanical outcome measures (e.g., nonlinear measures on EMG signals and force control data) and neuromotor treatments (e.g., non-invasive brain stimulation and functional electrical stimulation).

To summarize and introduce current research topics and tools in the neuromechanical research fields, our Special Issue titled “New Trends in Neuromechanics and Motor Rehabilitation” was launched in 2020, and a total of 10 studies were published. As a guest editor for this Special Issue, I have categorized the published papers in three sections: (a) neuromechanical approaches that characterized motor functions in specific population (six papers), (b) neuromechanical motor rehabilitation techniques (three papers), and (c) comprehensive perspectives in neuromechanical fields (one paper).

2. Neuromechanical Estimation on Motor Functions in Specific Population

For healthy individuals, Clark and Pethick [2] explored side-to-side comparisons (i.e., right/left and dominant/nondominant) of variability and complexity measures that potentially estimate knee muscle force control capabilities. The authors found that only right/left detrended fluctuation analysis (DFA) α , a nonlinear tool, indicated side-to-side difference in uninjured healthy people. These findings suggest that using complexity-based metrics may be a viable option to assess knee neuromuscular control functions in future studies. Min et al. [3] investigated the effects of static stretching and explosive contraction on the quadriceps spinal-reflex excitability and the latency time of the Hoffmann’s reflex and motor response. The findings indicated that both static stretching and explosive contraction did not statistically influence the spinal-reflex excitability and the latency time of motor responses. Importantly, the two protocols did not interfere with jumping performances. Overall, these results suggest that either static stretching or explosive contraction can be used for a part of pre-exercise activities.

Following four studies focused on specific population such as people with obesity, children with idiopathic toe walking, elderly people, and older women. Kim et al. [4] determined whether people with obesity differently adapt from treadmill to over-ground walking as compared with people with a normal-weight body mass index. Although both groups showed a transfer of temporal gait adaptation after split-belt treadmill walking, people with obesity showed greater asymmetry for double-limb support time. Potentially, these abnormal adaptation patterns indicated that obesity may influence temporal gait. Soangra et al. [5] examined the hypothesis that typical foot contact dynamics during walking are associated with children diagnosed with Idiopathic Toe walking (cITW) to a higher risk of falling. The authors found that cITW revealed inefficient walking patterns,



Citation: Kang, N. Special Issue of New Trends in Neuromechanics and Motor Rehabilitation. *Appl. Sci.* **2022**, *12*, 7902. <https://doi.org/10.3390/app12157902>

Received: 31 July 2022

Accepted: 2 August 2022

Published: 6 August 2022

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including greater push-off impulses, knee flexion angles, and vertical heel velocity that potentially increase the risk of falls. Lee and Byun [6] performed a pilot study to investigate the effects of aging on postural stability after stepping on a stair. The results indicated that older adults showed greater time to stabilization in the anterior and posterior direction than those for younger adults. These findings suggest that aging may increase the difficulty of dynamic postural control during walking. Kim et al. [7] explored bilateral deficits patterns in late postmenopausal women in their upper extremities. During bilateral and unilateral maximal grip force production tasks, late postmenopausal women revealed greater bilateral deficits (i.e., lower forces during bilateral contraction than the sum of unilateral forces) than those for younger women. The authors posited that age-related muscle weakness and estrogen deficiency may influence bilateral deficits patterns.

3. Neuromechanical Motor Rehabilitation Techniques

Kim et al. [8] determined whether resistance training protocols for upper and lower limbs improve arterial stiffness in healthy young adults, respectively. Their preliminary data found that the resistance training on upper extremities significantly decreased the augmentation index, indicating improved peripheral artery stiffness, and the resistance training on lower extremities showed no significant changes in arterial stiffness. Potentially, providing resistance training for upper extremities may effectively modulate local peripheral artery stiffness even in healthy young adults. To improve muscle functions in adult females with a sedentary lifestyle, Lee et al. [9] used core stabilization exercise programs. For 105 adult females, the exercise intervention improved muscular structural variables of the erector spinae, as indicated by the tensiomyography technique, and further increased functional variables of the muscles during the isokinetic muscular functional test. These findings suggest that the core stabilization exercise effectively decreases stiffness in the erector spinae, as well as isokinetic muscular functions of the trunk. A study performed by Kim and colleagues [10] explored the effects of dance-based aerobic exercise on the affective responses for younger adults with different fitness levels (i.e., sports major and non-major college students). Interestingly, heart rate, responses to the felt arousal scale and the feeling scale were estimated using tailor-made application on a smartwatch. They found that greater affective improvements were observed in the high fit group, suggesting that the level of physical fitness is a crucial factor for the relationship between exercise and affect.

4. Comprehensive Perspectives in Neuromechanical Fields

Cauraugh and Kang [11] conducted a comprehensive narrative review on the topic of bimanual movements and chronic stroke rehabilitation. In a mini-review article, the authors raised the importance of bimanual movement functions in chronic stroke patients because of potential unbalanced cortical activations between hemispheres (i.e., impaired affected hemisphere versus unaffected hemispheres). Specifically, chronic stroke patients showed deficits in kinetic and kinematic control of their upper extremities. Thus, a recovery of the bimanual motor functions can be one of crucial motor rehabilitation goals post stroke. Based on this assumption, many prior studies have focused on activity-based movement treatments, as well as bimanual movement interventions (e.g., bimanual force control practices and bimanual movement actions combined with neuromuscular electrical stimulation) and provided the evidence that patients with stroke revealed improvements in both the bimanual execution and functional recovery of their paretic arm. Taken together, these findings provide a possibility that bimanual movement training protocols in addition to either non-invasive brain stimulation techniques or pharmacological therapies that potentially increase the symmetry of cortical activations between hemispheres.

5. Future Suggestions

The current Special Issue has gathered various scientific approaches to emphasizing neuromechanical tools in cross-sectional research, intervention design, and review studies.

Despite these new findings, an effort to connect altered neurophysiological patterns in the higher center (e.g., brain level) with movement execution is still necessary to further identify new motor control mechanisms in human. Furthermore, biobehavioral science researchers and motor rehabilitation specialists should use various neuromechanical principles to estimate, recover, and understand motor control capabilities in various populations.

Funding: This research received no external funding.

Conflicts of Interest: The author declares no conflict of interest.

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