Effects of assistive force on muscle activities during isometric elbow flexion

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Abstract of Dissertation

Aging causes deterioration in physiological functions and cognitive skills, as well as psychological impairment which prevents the elderly from having a healthy lifestyle and living independently. To improve the quality of life of elderly and impaired persons, assistive technology (AT) has been developed so that they can become active and independent. Thus, understanding the interaction between a human and a device (physically and cognitively) is crucial in order to ensure the successful application of the AT device. The main objective of this dissertation is to identify the characteristics of human muscle response and adaptation toward the application of external assistive forces while performing isometric elbow flexion (IEF) tasks under various conditions with both young and elderly participants.

The first study targeted young adult participants. It was found that muscle activity in the agonist muscle (biceps) and perceived exertion reduced as the level of assistive force increased. In addition, the effectiveness (the ratio of measured muscle activity to theoretical muscle activity) of the agonist muscle activity was influenced by a combination of the levels of targeted workload and assistive force.

In the second study, elderly participants showed a similar trend towards reduction in muscle activity in both muscle (agonist and antagonist), particularly at higher targeted workloads. Similar to the young participants, the effectiveness of agonist muscle activity was also influenced by the same combination of targeted workload level and assistive force. However, contrary to the findings in the first study, perceived exertion in elderly participants did not decrease and was rated lower than by the young participants. The underestimation of assistive force exertion could be caused by a deterioration in proprioception and slower cognitive processing of physiological cues as a consequence of the aging process.

Meanwhile, the third study showed the effects of two-day repetitive training for IEF with assistive force on the effectiveness of assistive force against the agonist muscle. Although the training group with assistive force (assisted group) showed a decrease in both agonist and antagonist muscle activities as well as perceived exertion during IEF with assistive force, the effectiveness of assistive force did not change significantly. Therefore, it is suggested that longer training periods should be considered to observe improvements in effectiveness.

In conclusion, these three investigations successfully provide a basic knowledge of physiological and cognitive human responses, as well as the adaptation against external assistive forces for human movement, which would be useful for future robust AT device development.