Effects of assistive force on muscle activities during isometric elbow flexion

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Summary of dissertation

The main objective of this dissertation is to provide basic knowledge of human adaptation against external assistive forces for future assistive technology (AT) device development.

In chapter 1, the study explains on aging society and the impact of aging on human. The decline in physical, cognitive and psychology function would constrain the functional performance in elderly individuals, which is required for independent living and enjoying a healthier lifestyle. Thus, AT is introduced to aid the elderly perform daily task so that they can live independently. Nevertheless, humans have unique reactions against external stimuli and stressors of AT devices such as self-defense and adaptation to mechanical assistive forces. The unique reactions depend on various factors, including physiological and psychological aspects. Therefore, the effectiveness of assistive forces on humans cannot be predicted only from the engineering and technical aspects of an AT device. Thus to understand the adaptation of human towards AT device, investigations of the muscle response toward external assistive force application while performing isometric elbow flexion task are conducted.

In chapter 2, the first investigation focuses on young adult participants. The objective is to understand the upper arm agonist (bicep brachii, BB) and antagonist (tricep brachii, TB) muscle responses to changes in assistive force from surface electromyogram (sEMG) data and rated perceived exertion (RPE). Both data are statistically analyzed by using analysis of variance (ANOVA) for significant effect and interaction. Next, the effectiveness of different assistive levels and workload levels in young adults is determined. It is 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 is affected by a combination of the levels of targeted workload and assistive force.

In Chapter 3, similar investigation is performed on elderly participants as in reality, the AT device is designed for elderly and disabled person. Therefore, it is important to include elderly people in this research to understand muscle response in elderly towards assistive force. Similar experiment procedure is performed as in chapter 2. The results showed a similar trend towards reduction in muscle activity in both muscle proving that elderly are able to adapt to the assistance. However, contrary to chapter 2, perceived exertion in elderly participants did not decrease and rated lower than by the young participants. It is expected that aging process causes deterioration in proprioception and slower cognitive processing of physiological cues hence the underestimation of assistive force exertion.

In chapter 4, the effects of two-day repetitive training on the effectiveness of assistive force against the agonist muscle is studied. The participants are divided into training and control group with different protocol in each group, but both groups have to perform 15 isometric elbow flexion trials a day. 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 suggesting that the two-day training program is not effectively improved motor learning for better assistive force adaptation and effectiveness.

In chapter 5, the study presents the general discussions and conclusions from previous chapter 2, 3 and 4. This study is able to provide basic knowledge of human adaption, physiologically and cognitively against external assistance from different age group factor; young and elderly and the training factor. The finding of this study indicates

that the elderly are able to effectively adapt the assistance despite the lower effectiveness value as compared to young group. In addition, combination of sufficient assistive force and submaximal workload levels influence AT device effectiveness. Thus, proper selection of assistive force levels and proper training period and procedure could ensure optimized and safe design of AT device.