A Study of Keyboard Instrument Performance Tasks and Evaluation by sEMG and MIDI Velocity for Hand Rehabilitation of Stroke Patients

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Abstract

The number of stroke patients in Japan is about 300,000 per year, with 85% having paralysis and 25% having physical paralysis. If paralysis of the fingers remains, it causes a decrease in activities of daily life and an obstacle when returning to work. The rehabilitation of the fingers becomes an issue. In this study, 3 stroke patients and 7 healthy adults' control group were the subjects. The purpose was recovery of hand dexterity, and performance training of keyboard instruments was performed on the paralyzed fingers (patient group) or non-dominant hand (control group). The training effect was evaluated by surface electromyography (sEMG) during performance and MIDI data of performance. sEMG was measured on FPLM and FDSM, and normalized with maximum muscle strength (%MVC). As MIDI data, we used velocity corresponding to the strength of the performance. As a result of testing with 2-way ANOVA before and after training and due to the strength of performance, the %MVC of the patient group did not change significantly both before and after training and in strength and weakness for both FPLM and FDSM. There was no significant difference in %MVC in the control group before and after training for both FPLM and FDSM, but there was a significant difference between the levels of strength and weakness. On the other hand, velocity was not significantly different before and after training in the patient group, but there was a significant difference between strength and weakness ($p < .01$). In the control group, there was a significant difference between strength and weakness ($p < .001$), and there was a significant tendency before and after training ($p = .08$). In addition, there was an interaction between before and after training and between the strength and weakness conditions ($p < .05$). By using velocity, it can be expected to capture changes in motion that cannot be observed with sEMG. In the future, we will also observe the difference in velocity for each finger. Despite increasing interest in keyboard playing as a strategy for repetitive finger exercises in fine motor skill development and hand rehabilitation, comparative analysis of task-specific finger movements relevant to keyboard playing has been less extensive. This study examined, whether there were differences in surface EMG activity levels of forearm muscles associated with different keyboard playing tasks. Results demonstrated higher muscle activity with sequential keyboard playing in a random pattern compared to individuated playing or sequential playing in a successive pattern. Also, the speed of finger movements was found as a factor that affect muscle activity levels, demonstrating that faster tempo elicited significantly greater muscle activity than self-paced tempo. The results inform our understanding of the type of finger movements involved in different types of keyboard playing at different tempi. This helps to consider the efficacy and fatigue level of keyboard playing tasks when being used as an intervention for amateur pianists or individuals with impaired fine motor skills. Specific and intensive repetitions of finger movements effectively mediate the activation of corresponding muscle and brain areas, which leads to changes in functional muscular activities and cortical organization

Keywords: stroke; paralysis; rehabilitation; finger; fatigue; electromyography;

Biography

Maki Nanahara received the B.M. degree (Music Performance) from the University of Alaska, Anchorage, in 1995 and M.M. degree (Music Education/Music Therapy course) from Nagoya College of Music in 2007. She currently studies in the Doctoral Course of the Department of Computer Science and Engineering, Toyohashi University of Technology, Japan.