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Comparison of Muscle Activation during Dominant Hand Wrist Flexion when Writing

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Abstract. [Purpose] This study investigated the difference in muscle activation of the dominant upper extremity in right-handed and left-handed persons during writing. [Subjects] There were 36 subjects (16 left- handers/ 20 right- handers), and the study was conducted from 03/01/2012 to 30/3/2012. [Methods] Six electrodes were attached to the FCU (flexor carpi ulnaris), FCR (flexor carpi radialis), ECU (extensor carpi ulnaris), ECR (extensor carpi radialis), and both UT (upper trapezius) muscles. [Results] FCU muscle activation was 16.77±9.12% in left-handers and 10.29±4.13% (%MVIC) in right-handers. FCR muscle activation was 19.09±9.43% in left-handers and 10.64±5.03% in right-handers. In addition, the UT muscle activation on the writing hand side was 11.91±5.79% in left-handers and 1.66±1.19% in right-handers. [Conclusion] As a result of this study, it was discovered that left-handers used more wrist flexion in performance of the writing task with the dominant upper extremity than right-handers, and that the left-handers activated the wrist and shoulder muscles more than the right-handers. These results indicate a potential danger of musculoskeletal disease in left-hander.
Key words: Hand function, Left-hander, Muscle activation

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INTRODUCTION

Human perform various activities with their hands[1)]. One of the hands is more skilled and characteristically is used to carry out more skilled work[2)]. The dominant hand is clearly utilized in local muscle activities such as writing, eating, drawing, and throwing[3)]. More than 90% of the population is right-handed[4)]. The remaining 10% are reported to be left-handed[5)].

Ten percent of the population is left-handed. Most studies on left-handers have dealt with genetic causes or relations between the dominant hand and language, and there are insufficient numbers of studies on other themes. For example, left-handers have risk factors for accidents at work in various areas, as evidenced by the fact that the frequency of accidents among left-handers is reported to be higher than that of right-handers[6)].

Writing is an everyday activity that is typically performed with the dominant hand[7)]. Left-handers have more difficulties writing than right-handers. While right-handers place the hand below the area in which they are writing, left-handers invert the writing posture by placing the hand above the area in which they are writing[8)]. When writing letters, they place the right side of the paper to the left of the very middle line of the body. Therefore, when left-handers write letters, they sit to the left side of the desk so that their arm movement is not restricted. In addition, easing tension by ensuring that the wrist or shoulder does not excessively flex when writing letters would prevent any unnatural change of posture[9)].

The purpose of this study was to investigate if there is any difference in muscle activation (%MVIC) according to the dominant side in writing. Through this research, the study is intended to prevent musculoskeletal disorders in left-handers by identifying the risks for musculoskeletal disorders and restricted work performance for left-handers, and to further suggest the need for work performance enhancement through an ergonomics approach.

SUBJECTS AND METHODS

Among the subjects who participated in the research, there were 16 left-handers and 20 right- handers. Of the left-handers, there were 4 male subjects (25.00%) and 12 female subjects (75.00%), and the average age was 23.37 (±3.34). Of the 20 right handers, there were 13 male subjects (65.00%) and seven female subjects (35.00%), and the average age was 24.42 (±4.04) (Table 1). The subjects did not have any diseases related to the hands, fractures, or past histories of diseases or fractures, and they were normally healthy persons without neurologic disorders. Before the study, the principal investigator explained all procedures to the subjects in detail. All subjects signed an informed consent form, which was approved by the Inje University College of Human Health Science Studies Committee.

EMG data for measuring muscle activation was col-

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Table 1. General characteristic n=36

		Left-hander (n=16)	Right-hander (n=20)
Gender	Male	4 (25.00%)	13 (65.00%)
	Female	12 (75.00%)	7 (35.00%)
Age		23.37 (±3.34)	24.42 (±4.04)

lected through the use of a Bagnoli EMG System (Delsys Inc, Boston, MA, USA) to analyze writing performed by the dominant hand. Before the experiments, the skin of each subject was cleaned using an alcohol cotton ball to remove foreign substances at the electrode adherence point, after which markers were attached. Six electrodes were attached to the FCU (flexor carpi ulnaris), FCR (flexor carpi radialis), ECU (extensor carpi ulnaris), ECR (extensor carpi radialis), and both UT (upper trapezius) muscles.

To measure muscle activation, the sampling frequency for electromyography signals was set to 1,000 Hz. Electromyography signals entering through the six channels were collected, root mean square (RMS) values were calculated, and the values were then normalized as ratio maximal voluntary isometric contraction (MVIC and %MVIC. For each muscle, MVIC was measured three times, and the average was calculated. Each task was performed three times, and the measured values were used to calculate the MVIC and %MVIC.

The writing items were the 7 subtests of the Jebsen-Taylor Hand Function Test[10, 11]. The collected data were analyzed using SPSS for Windows for frequency, and the differences were examined using an independent t-test.

RESULTS

When conducting the writing activity, the FCU muscle activation was 16.77±9.12% in left-handers and 10.29±4.13% (%MVIC) in right-handers. The results were statistically significant. FCR muscle activation was 19.09±9.43% in left-handers and 10.64±5.03% in right-handers. The results were statistically significant. In addition, the UT muscle activation on the writing hand side was 11.91±5.79% in left-handers and 1.66±1.19% in right-handers. The results were statistically significant. There were no significant differences in ECU, ECR, or nondominant side UT muscle activation (Table 2).

Table 2. %MVIC depending on dominant hand

	Left (n=16)	Right (n=20)
	M ± SD	M ± SD
FCU	16.77 ± 9.12*	10.29 ± 4.13*
FCR	19.09 ± 9.43*	10.64 ± 5.03*
ECU	27.98 ± 9.65	21.77 ± 7.88
ECR	17.47 ± 7.30	10.82 ± 5.75
Nondominant UT	3.43 ± 2.83	7.32 ± 4.14
Dominant UT	11.91 ± 5.79*	1.66 ± 1.19*

FCU (flexor carpi ulnaris), FCR (flexor carpi radialis), ECU (extensor carpi ulnaris), ECR (extensor carpi radialis), nondominant UT (nondomianant hand side upper trapezius), dominant UT (dominant hand side upper trapezius). *Significant difference<0.05

DISCUSSION

Ninety percent of the population is right-handed, and most living environments are designed for the right-handed[12]. Designs focused on the righted-handed cause many difficulties for left-handed persons, but studies of this issue are rare[13]. This study is intended to lay a scientific foundation for left-hander intervention through quantified analysis of the function of the dominant upper extremity of left-handers when conducting work-related tasks.

The results suggest that in the writing activity, left-handers flexed the wrist more than right-handers. In addition, the muscle activations of the FCU and FCR, as well as that of the UT on the writing hand side, were higher among left-handers than right-handers. The results are meaningful in that they scientifically identify the function of the upper extremity based on the dominant hand, as there has previously been insufficient empirical data on the subject. In addition, it is thought that accumulation of with regard to left-handers will expand understanding in this area. Based on the results of this study, there is a need to more realistically consider stress in left-handers resulting from the left hand in a world where right-handers task the lead.

This study was conducted on people with normal use of the left hand. In left-handers, the risks musculoskeletal disorders and performance problems were previously examined. Therefore, left-handers with musculoskeletal disorders would have even bigger risk factors. Among them, stroke is the disease most characteristic of kinetic function disorder[14]. There is a need to examine whether there are differences in work performance between cases in which stroke patients began to use the right hand because of hemiparalysis on the left side and cases in which stroke patients began to use the left hand because of hemiparalysis on the right side. This would provide importance evidence for proving the lowered work performance of left-handers. This study could be expanded to examine schizophrenia and other developmental disorders with a high occurrence rate among left-handers.

This study is meaningful in that it offers scientific data in consideration of left-handers, given that there is insufficient ergonomic research based on dominant hand. In addition, this study is meaningful in that it confirmed the need for an occupational therapy approach aimed at enhancing work performance and maximizing independence.

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