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Study For The Effect Of Middle Finger Grip Span On Ring Finger Force In The Maximum Gripping Task

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Abstract

Grip strength is affected by such as enslaving effect, force sharing effect, and force deficit effect relating to the interaction among fingers. The author attempts to analyze ring finger strength according to grip span of adjacent middle finger. 5 male graduate students participated as subjects in this experiment. The grip span has been applied from 45mm to 60mm to investigate the effects of a coordination of grip spans on the ring and middle finger strength. Results showed that ring finger strength was the smallest in case of ring finger grip span of 65mm. Ring finger strength was the largest in case of middle finger grip span of 45mm. In general ring finger strength shared a increasing trend when the grip span of the middle finger decreased. This study has an implication that the grip span of ring and middle fingers influences force sharing effect on ring finger.

Keywords
Finger interaction, Grip strength, Finger forces, MFFM system

1. Introduction
Many researchers were studies with various purposes on hand through grip strength. The grip strength was affected by anthropometric data and external characteristics of grip strength measuring equipments (Talsania and Kozin, 1998; Kim and Kong, 2008). The studies on finger force were through many approaches such as establishing models of finger force through experimentation. As seeing the result of finger forces, although it apparently seems different depending on the way to measure strength, when measuring strength of power grip, the middle finger was greatest and depending on each circumstance, there has been much difference between index finger and ring finger. Grip strength is affected by such various effects as enslaving effect, force sharing effect, and force deficit effect relating to the interaction among fingers (Danion et al., 2003; Kim, 2006). Index finger strength had a tendency of decrease as the increase of middle finger grip span in same grip span of index and middle finger. When the task needs strength of index finger to gain an effective functionality, it is preferred that longer index grip span than middle one, or the same grip span of index and middle finger at least. The main purpose of this study was investigate the effects of the grip spans of middle and ring fingers on the ring finger strength

2. Methods

2.1 Subject
A total of 5subjects participated in the experiments. Subjects were graduate students who did not experience any musculoskeletal disorders in their upper limbs. At the beginning of the experiment, informed consent was obtained and hand length (the distance from the crease of the wrist to the tip of the middle finger with the hand held straight and stiff) were measured. The average hand length was 18.5mm. The information on the subjects is illustrated in Table 1.

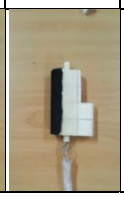
Table 1: Information of subjects' anthropometry

	Average ± SD
Age	28.5±2.8
Height (cm)	176.5±4.3
Weight (kg)	73.3±8.9
Hand Length (cm)	18.5±0.7
Hand Width (cm)	8.3±0.4
Hand Thickness (cm)	3.1±0.3
Hand Circumference (cm)	16.0±2.7

2.2 Apparatus

This study used to a MFFM(Multi-Finger Force Measurement system) system that was developed to evaluate individual and total finger forces when all fingers have identical grip spans as well as varying grip spans(Kim and Kong, 2008). This study changed the grip span between index and middle fingers to measure the grip strength of each finger according to 25 types of grip span in total. The grip spans of ring and little fingers were the same as the grip span of middle finger over all 25 of handle type to minimize the effects of other fingers' coordination on the index and middle finger forces (Table 2).

Table 2: 25 types of grip span (MFFM system)

Finger	Grip Span									
Index Middle	45 mm					…	65 mm			
Ring Little	45 mm	50 mm	55 mm	60 mm	65 mm		45 mm	50 mm	55 mm	60 mm	65 mm
Figure						…					

2.3 Procedure

Before the experiment, the purpose and procedure of the experiment was described to the subjects for their agreement, their personal information was recorded, and measurement on their hand was performed. The subjects sat straight on chairs and maintained the angle of their elbow at 90˚, and their wrist at 0˚ to measure the maximum grasping power for each handle, and all experiments were executed under identical conditions. The subjects were asked to repeat the exertions one times for each shape. Thus each subject randomly performed a total 25 trials and a 3-minute recess was allowed between trials.

2.4 Design of experiment

We selected grip span of middle(5 level: 45, 50, 55, 60, 65mm) and ring finger(5 level: 45, 50, 55, 60, 65mm) as independent variable for measuring each finger forces and grip strength of grip span of middle and ring finger by using MFFM. The dependent variables of the study were the ring finger force. SPSS (SPSS 18.0) was used for the descriptive statistics and the analysis of variance (ANOVA) with a 2×2 between subjects design of grip span (middle and ring) as the independent variables.

3. Results

Then the force exerted by ring finger was analyzed in accordance with grip span of middle and ring finger. The result of the analysis was statistically significant in respect to the ring finger force, exhibited statistical significance in proportion to the middle($p=0.002$) and ring($p<0.001$) finger grip span. As shown in Table 2, illustrates the contribution of force exerted by fingers according to middle and ring finger grip span to the grip, and the symbols of alphabet on each column demonstrates the Tukey test results.

Table 3: Results of ring finger force

Ring finger force		Middle finger grip span					
		45mm	50mm	55mm	60mm	65mm	average
Ring finger grip span	45mm	72.1	71.9	54.5	49.5	41.8	57.9(B)
	50mm	89.4	80.0	84.7	59.8	52.0	73.2(AB)
	55mm	82.0	88.0	91.2	71.8	59.8	77.6(A)
	60mm	93.3	91.6	79.3	68.7	49.5	77.6(A)
	65mm	68.0	84.5	69.9	58.2	48.8	65.1(AB)
	average	81.0(A)	82.9(A)	75.3(AB)	61.6(BC)	50.4(C)	

(Alphabet means significant grouping in statistics, A= Tukey test results of ring finger forces for Middle finger grip span, a= Tukey test results of ring finger forces for ring finger grip span, Ring finger force, unit: N)

In particular, middle finger grip span of 45, 50mm led to the greatest level (81.0, 82.9N) of ring finger strength, whereas grip span of 65mm led to the smallest (50.4N) strength. Ring finger grip span of 55, 60mm led to the greatest level (77.6, N) of ring finger strength, whereas grip span of 45mm led to the smallest (57.9N) strength (Table 3). When grip span of little finger increased from 45mm to 60mm, it was found that ring finger force also increased as well and when it gets over 60mm, it rather decreased. On the other hand, when grip span of middle finger increased from 45mm to 60mm, it rather decreased.

4. Discussion

According to previous literature, there exists interactive association between fingers in case of force by multiple fingers (Li et al., 1998, 2000). Ring finger force was statistically significant difference depending on grip span of middle and ring finger. Ring finger force had a tendency of decrease as the increase of middle finger grip span in same grip span of middle and ring finger. But ring finger force had a tendency of abruptly decrease as difference between grip spans was more than 15mm. When grip span of ring finger was smaller than of middle finger, ring finger force then subsequently decreased. In this study, investigated interaction between each finger, we analyzed each finger forces through experiment. However, this study had a few limitations such as not considering many other types of handle and only few subjects were recruited and poor combination of grip span. The author expects to develop a prediction model on finger strength by considering such effects in further study by complementing such short comings.

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Biography

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