

Comparison of Task Performance, Hand Power, and Dexterity with and without a Cock-up Splint

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Abstract. [Purpose] The purpose of this study was to investigate the difference in task performance, grip and pinch strength, and dexterity with and without cock-up splints, which are widely used in occupational therapy practice. [Methods] Twenty-three participants performed Jebsen-Taylor hand function test and grooved pegboard for task performance and dexterity. The power grip and pinch strength was measured using Jamar hydraulic hand dynamometer and pinch gauge. [Results] In the result of the Jebsen-Taylor hand function test, task performance with the cock-up splint was slower compared to without the splint for all items. Men's grip power with the cock-up splint was found to be significantly decreased compared to without the splint. Women's grip and palmar pinch strength with the splint decreased significantly compared to without the splint. In the grooved pegboard test, the dexterity of both men and women with the cock-up splint decreased significantly compared to without the splint. [Conclusion] To assist patients to make wise decisions regarding the use of splints, occupational therapists must have empirical knowledge of the topic as well as an understanding of the theoretical, technical, and related research evidence. The results of this study will be useful in the analysis and understanding of changes in hand function in splint applications for people with hand dysfunction.

Key words: Dexterity, Hand power, Splint

(This article was submitted May 9, 2013, and was accepted Jun. 7, 2013)

INTRODUCTION

Splints can be categorized as static or dynamic splints. Such splints may serve a variety of purposes. Static splints are used for rest, prevention of further deformity, prevention of soft tissue contracture, and substitution for lost motor function. Dynamic splints are used for substitution of lost motor function, correction of a deformity, control of motion, and aid in fracture alignment and wound healing¹⁾.

Many studies have reported on the effects of splint applications for people with upper extremity dysfunction, such as decreasing hand and wrist pain²⁾, improving hand function³⁾, control of joint position and stability⁴⁾, decreasing muscle tone⁵⁾, and improving muscle strength⁶⁾.

Splints are used for a period of 1–24 months, and the average length of use has been reported to be 4 months⁷⁾. A splint application can lead to performance changes in activities of daily living (ADL). In rehabilitation, failure to adapt biopsychosocially can cause a decrease in voluntary participation. It is important to understand the changes that occur after splint application⁸⁾.

The purpose of this study was to determine the difference in hand function between participants who were and were not wearing a cock-up splint, which is widely used in occupational therapy practice. In particular, we investigated the differences in task performance, grip strength, and dexterity.

SUBJECTS AND METHODS

Twenty-three healthy individuals, who were “I” University students without musculoskeletal problems, were recruited for this study. The cock-up splints used in this study were created using low temperature thermoplastic material. They were customized to the forearms and hands of the participants and covered two-thirds the length of the forearm on the volar side. All participants read and signed an informed consent form, approved by Inje University Ethics Committee for Human Investigations prior to their participation.

Assessments of performance when participants were wearing or not wearing the splints were carried out in a random order. Task performance was assessed using the Jebsen-Taylor hand function test; power grip was measured using a Jamar hydraulic hand dynamometer (PC 5030JI, Preston Co., USA); and pinch grip (tip pinch, lateral pinch, palmar pinch) was measured using a Jamar hydraulic pinch gauge (PC 5030, Preston Co., USA). Dexterity was measured using a grooved pegboard. Data were analyzed using the SPSS 18.0 statistics package for Windows and a signifi-

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cance level of 0.05 was used in all analyses.

RESULTS

In this study, there were 7 men (30.4%) and 16 women (69.6%) in the sample. All participants were right handed. Subjects' average age was 22.35 ± 2.17 years old; their average height was 165.48 ± 7.21 cm; and their average weight was 56.70 ± 9.75 kg (Table 1).

In the results of the Jebsen-Taylor hand function test, the scores obtained when wearing the cock-up splint were slower than without the splint for all items. The time spent in the writing item was 12.94 ± 1.70 seconds without the splint and 14.33 ± 2.03 seconds with the splint. In the turning cards item, the speed was 4.41 ± 0.56 seconds without the splint, and 5.31 ± 1.21 seconds with the splint. With and without the splints, the amounts of time spent on the small objects item were 7.47 ± 1.91 seconds and 5.71 ± 0.65 seconds, respectively. The feeding simulation item took 6.17 ± 1.80 seconds without the splint and 7.36 ± 1.72 seconds with the splint, while the stacking checker item took 3.41 ± 0.83 seconds without and 4.77 ± 1.55 seconds with the splint. The amount of time spent on lifting large, light objects item was 2.49 ± 0.28 seconds without the splint and 3.31 ± 0.82 seconds with the splint. In lifting large, heavy objects item, it took 2.49 ± 0.28 seconds, to lift the item without the splint and 3.11 ± 0.05 seconds with the splint. All of these values showed a significant difference (Table 2).

Men's grip power wearing the cock-up splint was significantly lower compared to without the splint. The tip, lateral, and three pinch strengths when wearing the cock-up splint were lower compared to without the splint. However, no significant difference was observed. The grip power was 110.01 ± 9.39 kg without the splint and 82.12 ± 24.55 kg with the splint. Tip pinching was 16.01 ± 2.50 without the splint and 15.65 ± 2.43 kg with the splint. Lateral pinching was 26.13 ± 3.14 kg without the splint and 24.42 ± 2.77 kg with the splint, while three jaw pinching was 24.53 ± 4.59 kg without the splint and 22.62 ± 3.62 kg with the splint. Women's grip power and three jaw pinching with the splint were significantly lower compared to without the splint; the powers of tip and lateral pinching with the splint were not significantly lower than without the splint. The grip power was 61.60 ± 11.84 kg without the splint and 44.32 ± 10.25 kg with the splint. Tip pinching was 11.29 ± 2.01 kg without the splint and 10.88 ± 1.78 kg with the splint. Lateral pinching was 16.69 ± 1.42 kg without the splint and 16.27 ± 2.03 kg with the splint, while three jaw pinching was 15.40 ± 2.11 kg without the splint and 14.12 ± 2.16 kg with the splint (Table 3).

In the grooved pegboard test, men took 55.73 ± 4.86 seconds without the splint and 70.14 ± 5.96 seconds with the splint. Women took 53.46 ± 4.40 seconds without the splint and 69.65 ± 11.21 seconds with the splint. Both differences

Table 1. Characteristics of subjects (n=23)

Characteristics		
Gender	Male	7 (30.4)*
	Female	16 (69.6)*
Handedness	Left	0 (0.0)*
	Right	23 (100)*
Age (years old)		$22.4 \pm 2.2^{**}$
Height (cm)		$165.5 \pm 7.2^{**}$
Weight (kg)		$56.7 \pm 9.8^{**}$

*n (%), **Mean \pm SD

Table 2. The results of the Jebsen-Taylor hand function test (Unit: seconds)

Items	Without splint (mean \pm SD)	With splint (mean \pm SD)
Writing*	12.9 ± 1.7	14.3 ± 2.0
Card turning*	4.4 ± 0.6	5.3 ± 1.2
Small objects*	5.7 ± 0.7	7.5 ± 1.9
Feeding simulation**	6.2 ± 1.8	7.4 ± 1.7
Stacking checkers*	3.4 ± 0.8	4.8 ± 1.6
Lifting large, light objects*	2.5 ± 0.3	3.3 ± 0.8
Lifting large, heavy objects*	2.5 ± 0.3	3.1 ± 0.1

* $p < 0.05$, ** $p < 0.01$

Table 3. Comparison of handpower with and without a splint (Unit: kg)

			Without splint	With splint
Men	Power grip*		110.0 ± 9.4	82.1 ± 24.6
	Tip		16.0 ± 2.5	15.7 ± 2.4
	Pinch	Lateral	26.1 ± 3.1	24.4 ± 2.8
		Three jaw	24.5 ± 4.6	22.6 ± 3.6
	Power grip**		61.6 ± 11.8	44.3 ± 10.3
Women	Tip		11.3 ± 2.0	10.9 ± 1.8
	Pinch	Lateral	16.7 ± 1.4	16.3 ± 2.0
		Three jaw*	15.4 ± 2.1	14.4 ± 2.2

* $p < 0.05$, ** $p < 0.01$

Table 4. Comparison of grooved pegboard test results with and without the cock-up splint (Unit: seconds)

	Men*		Women*	
	Without	With	Without	With
Grooved pegboard test	55.7 ± 4.9	70.1 ± 6.0	53.5 ± 4.4	69.7 ± 11.2

* $p < 0.05$

were significant (Table 4).

DISCUSSION

The aim of this study was to investigate the effect of wearing a cock-up splint on task performance, grip and pinch strength, and dexterity. The Jebsen-Taylor hand function test was designed to provide a short, objective test of hand functions commonly used in ADL, and this was used to measure task performance in this study. For all items, performance was delayed when wearing the cock-up splint compared to not wearing the splint; the time difference with and without the splint was 2 seconds or less. This accords with Carlson and Trombly's results⁹; they emphasized that a time delay of 2 seconds or less can lead to a severe handicap in ADL.

Grip strength, three jaw pinch strength, and dexterity of women when wearing the cock-up splint showed a significant decrease compared to not wearing the splint. This was different from the results of Burtner et al.¹⁰ and Burtner et al.¹¹. Although it is impossible to definitively explain the contradiction of these results, there are two plausible explanations. The participants in the two previous studies had rheumatoid arthritis (RA) and cerebral palsy (CP), respectively. In contrast to the participants of this study, they had limited range of motion, pain, weakness, and other symptoms. This may have affected grip, pinch strength, and dexterity when not wearing the splint. Also, a cock-up splint might have supported the wrist of subjects with RA or CP, and reduced pain when wearing the splint. Three jaw pinching requires the use of most of the fingers. Thus, we consider this is the reason why only three jaw pinch strength showed a significant difference. Although grip strength, three-jaw pinch strength, and dexterity of women when wearing the cock-up splint exhibited significant decreases compared to not wearing the splint, the data were within the normal range reported by Park et al.¹² and Trites¹³.

In their study, Agnew and Mass¹⁴ reported that only 15.6% patients who were prescribed the splint were fully compliant due to the mildness of symptoms, poor cosmesis, discomfort, dysfunction in ADL, failure to relieve pain, and other causes^{15, 16}. Splint intervention should be customized by, taking the individual's unique biological or physical and psychosocial needs into consideration, along with personal factors and the patient's specific context, including life roles and environment⁸. Failure to use a holistic approach for splint application may result in patients experiencing unexpected challenges which cause them to stop wearing the splint. It is also the role of occupational therapists to teach patients about changes that could occur after splint application and suggest ways of coping with them.

To assist patients to make wise decisions regarding the use of splints, occupational therapists must have empirical knowledge, as well as an understanding of the theoretical and technical aspects and related research evidence¹⁷. Although the participants of this study were healthy persons, it would be useful to analyze and understand the changes of hand function in splint applications for people with hand dysfunction. Studies comparing hand functions of people with various musculoskeletal disorders with and without a splint will be needed in the future.

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