The Effect of Occupation-Based Bilateral Upper Extremity Training in a Medical Setting for Stroke Patients: A Single-Blinded, Pilot Randomized Controlled Trial

Sun Ho Kim, OT, PhD,* and Ji Hyuk Park, OT, PhD†

Background: Occupation used in occupation-based intervention requires the use of 2 naturally coordinated hands. *Objective:* To investigate by implementing occupation-based bilateral upper extremity training in medical setting to stroke patients and determine its effect in patients' bilateral upper extremity function recovery. *Methods:* A total of 20 patients were randomly assigned to the experimental group (occupation-based bilateral upper extremity training) or control group (task-based bilateral upper extremity training). The intervention of the 2 groups was conducted 30 minutes a day, 5 times a week, and 4 weeks long. The outcome was assessed using the Canadian Occupational Performance Measure, Stroke Impact Scale, Action Research Arm Test, the Yonsei-Bilateral Activity Test, Accelerometer, and participants were assessed at baseline and after 4 weeks. *Results:* There was a significant change in the satisfaction and performance status of occupational performance, strength, Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL), emotion, participant recovery in stroke recovery, gross movement in the function of the affected side, satisfaction in perform bilateral upper extremity in the experimental group compared to the control group. *Conclusions:* The clinical significance of this study is that this study demonstrated the effectiveness and usefulness of the training in the actual medical setting in improving upper extremity function and psychosocial factors.

Key Words: Bilateral training—occupation based—stroke—upper extremity

Introduction

Incomplete recovery after the onset of stroke causes temporary or lifelong disability that leads to impairment not only in the most of the daily activities like washing, feeding, bathing, dressing, toileting, and mobilizing, but in most of the leisure and activities that require social participation,[1] which present a major obstacle for patients to reintegrate into their society and their home.[2]

Occupation-based intervention represents an essential element in promoting reintegration to patients' ordinary life. Occupation-based intervention includes all daily activities, leisure or social participation, meaningful to the patients from which patients directly select and take part in a specific occupation to be used in therapy.[3] This occupation-based activity is set in near-real life settings,[4] promoting engagement and motivation to enhance occupation performance,[5] and provide independent, productive, and functional recovery to stroke patients.[3]

In their systematic review, Haslam and Beaulieu[1] reported that occupation-based intervention is more effective in improving both levels of independence in daily life and bilateral upper extremity function than does the general remedial intervention. Likewise, Shinohara et al[6] conducted a study with 36 chronic stroke patients and reported in its study that occupation-based intervention resulted in statistically significant enhancement in daily living quality and activity level than in traditional occupational therapy after 12 weeks of treatment, twice a week. Also, Skubik-Peplaski et al[7] reported that occupation-

From the *Department of Occupational Therapy, Young Kwang Rehabilitation Hospital, Wonju, Republic of Korea; and †Department of Occupational Therapy, College of Health Science, Yonsei University, Wonju, Republic of Korea.

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Address correspondence to Ji Hyuk Park, OT, PhD, Department of Occupational Therapy, College of Health Science, Yonsei University, Wonju, Republic of Korea. E-mail: otscientist@yonsei.ac.kr.

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based intervention activates cerebral cortex, improves bilateral upper extremity function, and causes generally positive changes for stroke recovery from its patient's case report

Occupation used in occupation-based intervention requires the use of 2 naturally coordinated hands.[8] In addition to activities of daily living, most occupation area such as in education, leisure, and social activities along with instrumental activities of daily living such as the use of computer and cooking require both hands. Bilateral upper extremity training grounded by neurological background that it promotes interhemispheric interaction and activates both affected and unaffected brain cortex,[9] and it is reported that both hand training group is more effective than 1-hand training in improvement of proximal arm function,[10] hand dexterity and wrist muscle contraction time,[11] time of task performance and cortical cortex activation.[12] It can be suggested that the use of a bilateral upper extremity is vital since it enhances participation and completion of independent tasks, and therefore improves the quality of life.[13]

Occupation is comprised of bilateral upper extremity activities, and bilateral upper extremity training can be used as a mean for occupation. Although the importance of occupation-based approach has been emphasized before,[6,7,14] almost 80% of domestic occupation therapy are conducted under medical setting that makes it restricted in time, in the environment, and from regulatory affairs. Thus, most of the training is bottom-up task-oriented training using majorly affected sides, or goal-oriented training. Also, bilateral upper extremity training is mainly used for symmetrical, asymmetrical, bilateral hand manipulation, yet is limited to suggesting simple task training or simple patterning methods[10,12,15]; however, there is hardly a research that has been applied to occupation-based activities.

Therefore, this research aims to investigate by implementing occupation-based bilateral upper extremity training in medical setting to stroke patients and determine its effect in patients' bilateral upper extremity function recovery.

Methods

This study was conducted from December 2017 to June 2018 and recruitment took place from December 18, 2017 to January 17, 2018. This was a single-blind study, and subjects were allocated randomly to the experimental or control group using a random number generated by computer software. All patients were blinded to group allocation. The study was conducted after approval from the Ethics Committee of Yonsei University School (approval number: 1041849-201711-BM-129-02). All subjects provided informed consent before study inclusion according to the Declaration of Helsinki 2004.

Participants

Subjects were 20 hemiplegic stroke patients admitted to the rehabilitation hospital in Wonju, Korea. The inclusion criteria and exclusion criteria for this study were screened by an assessor. The inclusion criteria were as follows: (1) patients diagnosed with stroke by medical specialist, (2) patients without cognitive impairments (Mini-Mental Status Exam-Korea [MMSE-K] $\geqq$24),[16] (3) patients who have a Brunnstrom stage of upper extremity distal and proximal part of 3 or more, (4) patients who understand the study's purpose and can provide consent for participation. Exclusion criteria were as follows: (1) patients who have had previous strokes or have other neurological or surgical conditions, (2) patients who recently participated in other rehabilitation research or drug experiments, (3) patients who had seizures repeatedly during treatment, (4) patients with visual perception problems (severe unilateral or visual field defects).

Twenty patients who met the criteria for the study were selected from 41 stroke patients who were considered to be able to participate in the study. Selected patients were randomly assigned to 10 patients in the experimental group and 10 in the control group. The results of the final 20 patients were analyzed (Fig 1).

Procedure

The experimental group was conducted one -on-one with the researchers and control group was conducted by 5 occupational therapists with 5 years of clinical experience. The experimental group performed "occupation-based bilateral upper extremity training in a medical setting." In the control group, "Task- oriented bilateral upper extremity training" was performed, and the training was conducted a total of 20 sessions, 5 days a week for 4 weeks. During the study period, all participants in the experimental group and control group continued to receive conventional physical therapy, occupational therapy, and medication. Conventional rehabilitation therapy was provided to the participants twice a day for 30 minutes with the neurodevelopmental treatment, Bobath technique, proprioceptive neuromuscular facilitation, pain management, hand manipulation skills, and dexterity training.

The experimental group performed occupation-based bilateral upper extremity training. To enable occupation-based activities, occupation that a patient wants in the present environment and that is achievable was selected, and the Canadian Occupational Performance Measure (COPM) was conducted where patient and therapist meet one by one to select and set goals. The only skilled occupational therapist (researcher) was involved in one-by-one interview, where he or she chose 3 or 4 tasks and followed occupational intervention in the order of importance. After the tasks selection and before the start of intervention, the patient and the therapist undergo

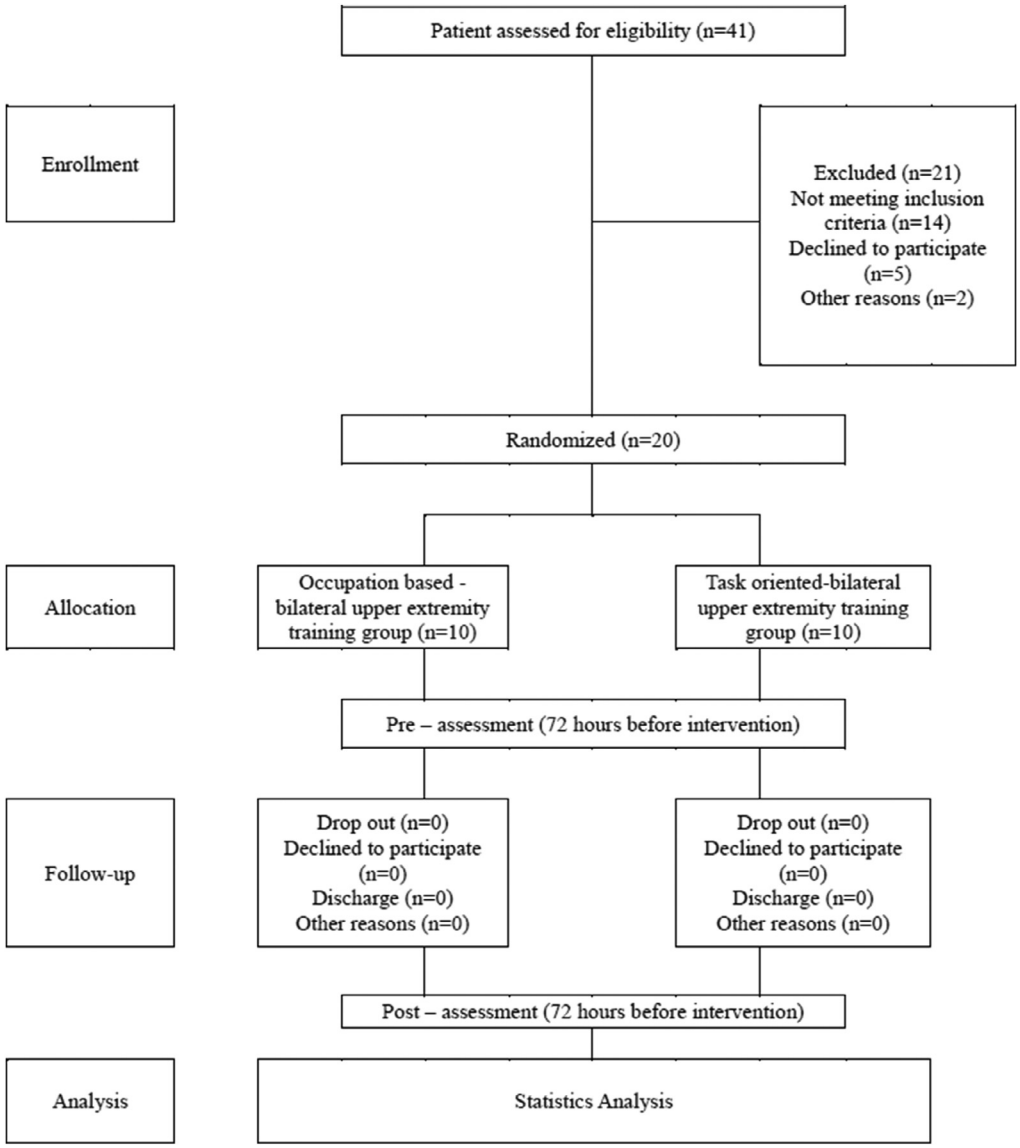

Figure 1. *Flow diagram of subjects in the study.*

examination session for 2 or 3 times to determine if the tasks are appropriate. Unless noted a problem, the patient continues the therapy. Therapist conducts intervention according to the protocol, performing activities as a patient does the same. In doing so, therapist continuously gives orders, and when performing the bilateral upper extremity activity, the patient follows therapists order according to the possible circumstances. Also, our group made it most possible for the patient to utilize one's own present environment. To allow most resembling activities possible like that of the patient's routine, there has been a discussion before the intervention to prepare necessities, place, and other things required. Intervention activities of the experimental group are described below (Table 1).

Task-based bilateral upper extremity training for the control group was conducted one by one with the skilled occupation therapist. Tasks were carefully designed so the patients can select by its task function, and the therapist continuously encouraged the use of both hands and gave a clue when patients found it difficult. Tasks were selected regarding previous research by Lewis and Byblow[17] and Stoykov et al,[10] and the bilateral upper extremity training task for this study is described below (Table 2).

The assessments were conducted one-on-one within the hospital's occupational therapy room. Preassessment was conducted within 72 hours before the intervention and post-assessment was performed within 72 hours after the intervention. Five occupational therapists with more than 3 years of experience excluding researchers conducted all the assessments in a fixed order. Ability of occupational performance, stroke recovery, motor function of affected side, quality of performance and satisfaction in perform bilateral upper extremity, and use of unaffected side and affected side was assessed at pretreatment and post-treatment.

Table 1. *Occupation-based activity of experimental group*

Subject	Brunnstrom stage	Activity	Place	Instrument
1	4	Clothing arrangement	Occupation therapy (OT) room, hospital room, ADL room	Patient's clothes
		Bath	Hospital bathroom	Patient's bathing tools (soap, towel hand towel, etc.)
2	4	Make-up	OT room	Patient's make-up tools (lipstick, brush, toner, lotion, foundation, etc.)
		Ironing	ADL room	Care-room iron, iron board, sprayer, patient's personal clothes
		Hand wash	Hospital room or bathroom	Care-room washing soap, washboard, small chair
3	5	Car wash	Hospital parking lot	Patient's car and car washing tool
		Basketball play	Hospital yard, nearby basketball court	Care-room basketball
4	4	Wearing clothe	Hospital room, care-room, ADL room	Patient's clothes and pants
		Cooking	ADL room	Care-room cooking tools (cutting board, knife, sauce, etc.), ingredients purchased by the care room
		Doing dishes	ADL room	Care-room scrubber, kitchen detergents, rubber gloves, etc.
5	3	Hand wash	Bathroom, washstand of the hospital room and ADL room	Care-room washing soap, washboard, etc.
		Simple cleaning	Hospital room, ADL room	Care-room mop, cloth, whisk broom, dustpan
6	5	Cooking (side dishes)	ADL room	Care-room cooking tools (cutting board, knife, sauce, etc.), ingredients purchased by the care room
		Doing dishes	ADL room	Care-room scrubber, kitchen detergents, rubber gloves, etc.
		Cross-stitch	OT room, hospital room, ADL room	Patient's cross-stitch thread, needle, etc.
7	5	Bath	Hospital bathroom	Patient's bathing tools (soap, towel hand towel, etc.)
		Car management	Hospital parking lot	Patient's cloth, wax, and other tools (car light replacement, tire replacement, car wash, etc.)
8	5	Personal care	OT room, hospital room, ADL room	Patient's bathing tools (soap, towel hand towel etc.), nail clippers, etc.
		Computer documents	OT room	Care-room computer, keyboard
		Woodcraft	Care-room, hospital room	Online purchased tools by the care-room (wood, nail, glue, hand globes, etc.)
9	6	Sewing	ADL room	Patient's sewing machine (portable)
		Knitting	ADL room, OT room	Patient's knitting needle, knitting yarn
		Magazine scrapping	OT room	Scrapbook purchased by the care-room, magazine, newspaper, glue, scissors
10	5	Cooking	ADL room	Care-room cooking tools (cutting board, knife, sauce, etc.), ingredients purchased by the care room
		Hand wash	ADL room	Care-room washing soap, washboard, small chair

Instrument and Outcome Measures

MMSE-K was used on the selection of research subjects to evaluate the cognitive ability necessary for task completion. MMSE-K was established in 1975,[16] translated in Korean, and standardized with inter-rater reliability value .99.[18] This test is commonly used as a simple cognition evaluation tool in clinical settings, with 12 items across 6 categories, and results of 24 points out of 30 in total are judged as cognitive impairment.

Brunnstrom stage was used as a subject screening tool for this study. Based on the observation that recovery of

Table 2. *Task-based bilateral upper extremity training task of the control group*

Task	Method
Cleaning desk with towels	Slightly roll 2 towels and put it 12.5 cm apart from each other on the desk. Put one's hand on the towel with both arms rested and bit near one's body. Hold the towel with each hand slightly and push both arms to the front. Then, rotate both arms externally, then internally.
Pushing sanding	Place both arms slightly attached to the body in a resting position and grab a handle of sanding by reaching both arms forward at the same time. Place upper extremity shoulder width, push the sanding to completely extend the joints, and come back to the start.
Drinking rehearsal	Put each cup 20 cm apart on both scaption positions. Extend both arms at the same time and grab each cup, bring it to the mouth and rehearse drinking, and then place 2 cups on the center of the torso.
Moving blocks	Place 10 wooden blocks in a line and 1 cm apart from each other 12.5 cm from the end of the desk. 5 cm behind the block, place 70 × 10 × 10 cm box. Grab each ends wooden block with each arm simultaneously and place them on the center of the box behind (end → center).
Cup stacking	Place 10 cups in a line left to right 2 cm apart from one another 12.5 cm from the end of the desk. Place the cups in line with the center of the body. Reach both arms at the same time and grab each cups at the outer end and stack it on the cup right next to it. Grab 2 stacked cups and stack them again onto the cup next to it again. After 5 repetitions, place stacked, 5 cups on the center of the desk.
Putting peg into and out of the pegboard	There are 20 pegs stuck in pegboard with the diameter of 2.5 cm and 12 cm in height. It is placed 12.5 cm away from the end of the desk, in line with the center line of the body. Place a basket 5 cm away from the right and left the side of the pegboard. Reach both arms at the same time and pull off the peg and place it in the basket. Continue pulling out the peg starting from the outer lower to upper and gradually toward the center.

motor function occurs at a certain stage, Burnnstrom stage was divided into 6 stages in respect to increasing in muscle tension, synergy pattern, and selective muscle control.[19]

Ability of occupational performance was measured by COPM. It is an assessment tool through 4-staged, semi-constructive meeting session[20] that makes patients thinks of what they want to do in their daily life, what is required, and expected, then measure performance and satisfaction of the selected activity in 10-point scale. In this study, COPM was used to evaluate patient's occupation-based activity selection and improvement after and before intervention. Cronbach's α test-retest reliability coefficient was .84-.92, which is very significant.[21]

Progress in stroke recovery was studied using Stroke Impact Scale (SIS). SIS detects recovery of patients with mild-to-moderate stroke and is comprised of 8 sections with 64 items for self-evaluation in 5-point scale. The sections are strength, Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) and mobility and hand function, memory and communication, emotion and participant. Inter-rater reliability for emotion section is $r = .57$, whereas the other section ranged $r = .70$-$.92$, which are very significant.[22]

To investigate the motor function for the affected side, our group used the Action Research Arm Test (ARAT). It translates task performance to the scoring system, assessing and observing action through the usage of the cylinder, cup, rod, etc. for 4 category movements that are grasping, gripping, pinching, and gross movement. ARAT is comprised of 4 sections and 19 items in total. Point 4 reliability of each section is grasp = .98, grip = .99, pinch = .99, gross movement = .98.[20]

Our group used the Yonsei-Bilateral Activity Test (Y-BAT) to analyze quality of performance and satisfaction in perform bilateral upper extremity. Y-BAT is comprised of evaluation that translates observation into the scoring system and self-evaluation questionnaire, measuring bilateral upper extremity functional level (1-5 points) and satisfaction after the performance (1-4 points). The tasks require the use of both hands to complete the given tasks. The specifics of the item are as the following: 5 items for activities without an object on the desk, sitting down, 12 for activities with objects on the table, 5 items with symmetrical movement, 11 for asymmetrical, and 1 item for bilateral upper extremity pattern control.

Accelerometer was used to measure the use of unaffected side and affected side. Accelerometer enables evaluation of activities of daily living in objective and noninvasive manner. Patients wear them on their wrist for 24 hours (excluding bath time) before and after the intervention to measure the result. Accelerometer is 3-axis acceleration motion detector fitmeter that sizes 3.5 cm × 3.5 cm × 1.3 cm (width × length × height) and weighs 13.7 g. The sensitivity was set to 4G(−122.25 cm/s^2∼+122.25 cm/s^2).[23] Patients can perform all activity while wearing it on the wrist, and measures usage result by wearing it for 24 hours (excluding bath time). For measurement parameters, our group used Fitmeter Manager v1.2 software. The sample rate for X, Y, and Z axis of the accelerometer under the lower arm was

32 Hz, and the acceleration of the X, Y, and Z axis (aX, aY, and aZ) was summed and processed as signal vector magnitude.

Statistical Analysis

The collected data were analyzed using SPSS 21.0 (IBM Corp., Armonk, NY). The homogeneity of the experimental group and the control group before the intervention was verified using the chi-squared and Mann-Whitney *U* tests. The Wilcoxon signed rank test was used to test for significance before and after intervention. An analysis of covariance (ANCOVA) was used to compare changes between the groups, and the covariance was set as a preassessment of each group. Statistical significance was set at $P < .05$. The effect size index η^2 (ANCOVA) was also calculated. Data were presented as the mean (standard deviation).

Results

There was no statistically significant difference in the general characteristics of the subjects between the groups (Table 3).

Within the experimental group, the results showed significant improvement in COPM and strength, ADL and IADL, hand function, emotion, participant, grasp, grip, gross movement, and Y-BAT and accelerometer compared with baseline. In addition, the control group showed significant improvements in strength, ADL and IADL, hand function, grasp, grip, and gross movement, quality of performance, and Y-BAT and accelerometer (Table 4).

The ANCOVA identified a greater improvement in the treatment than control group on performance ($P < .05$, $\eta^2 = .44$) and satisfaction ($p < .001$, $\eta^2 = .72$) of occupation performance, and strength ($P < .05$, $\eta^2 = .29$), ADL and IADL ($P < .05$, $\eta^2 = .45$), emotion ($P < .05$, $\eta^2 = .59$) and participant ($P < .05$, $\eta^2 = .47$) in SIS, and gross movement ($P < .05$, $\eta^2 = .46$) in ARAT items and usage of the affected side ($P < .05$, $\eta^2 = .27$), and satisfaction ($P < .05$, $\eta^2 = .42$) in perform bilateral upper extremity (Table 4).

Discussion

This pilot study demonstrated the feasibility of occupation-based bilateral upper extremity training in a medical setting for recovery of bilateral upper extremity dysfunction in stroke patients. The result showed that both groups showed improvement in performance of occupation performance, grasp, grip, and gross movement of the affected side, recovery of strength, ADL and IADL and hand function, quality of performance in perform bilateral upper extremity, and in the usage of both affected and unaffected side. However, the experimental group showed significant improvement than did the control group in performance and satisfaction of occupation performance, and SIS subitems such as strength, ADL and IADL, emotion, and recovery of the participants. Also in ARAT items, gross movement and usage of the affected side, and satisfaction in perform bilateral upper extremity improved significantly greater than that of the control group.

Bilateral upper extremity training triggers more activity in both brain hemispheres than unilateral training by decreasing inhibition at the cerebral cortex,[9,24] and maximizes temporal and spatial combination effect through neural circuits in the brain and in the cortex.[25] Bilateral upper extremity training has been reported to provide the basis for functional enhancement by demonstrating highly evoked potential and activation of the supplementary motor area, which plays an important role in continuous exercise as it plans out whole and voluntary movement,[12,26] and it was also reported from meta-analysis that this training is effective in encouraging the use of upper affected side and improving ADL performance.[27] This study also demonstrates a similar finding from the training of both the experimental and control groups resulted in the improvement of upper extremity muscle strength and function, thereby enhancing ADL performance and quality of performance in perform bilateral upper extremity.

Occupation-based bilateral upper extremity training in the medical setting was effective in improving

Table 3. *General characteristics of subjects*

Classification		Experimental group (n = 10)	Control group (n = 10)	*P*
Gender	Male	4	4	.37
	Female	6	6	
Age (yr)		57.3 ± 9.00	61.7 ± 7.40	.99
Stroke type	Infarction	5	5	1
	Hemorrhage	5	5	
Paresis	Right	7	4	.65
	Left	3	6	
Time since injury (mo)		8.6 ± 2.11	9.2 ± 2.14	.58
MMSE-K (score)		28.1 ± 1.66	28.2 ± 1.87	.63
Brunnstrum stage	Shoulder	4.6 ± .52	4.8 ± .63	.483
	Hand	4.6 ± 1.52	4.8 ± .63	.483

Table 4. *Comparison before and after intervention within groups and between groups*

Evaluation			Pretest	Post-test			Between-groups			
			M ± SD		*Z*	*P*	CI		*F*	*P* (η^2 value)
COPM (score)	Performance	E	3.63 ± 1.04	5.41 ± 1.18	−2.692	.007*	.25	1.63	8.39	.01* (.44)
		C	4.09 ± .8	4.5 ± .52	−1.579	.11				
	Satisfaction	E	2.83 ± 1.32	5.5 ± 1.08	−2.814	.005*	.80	2.31	19.02	.00** (.72)
		C	3.86 ± .82	4.2 ± .63	−1.604	.1				
SIS (score)	Strength	E	10.3 ± 2.3	14.1 ± 3.24	−2.825	.005*	.18	1.73	6.83	.018* (.29)
		C	9.6 ± 2.6	12.3 ± 2.94	−2.85	.004*				
	ADL and IADL	E	32.5 ± 6.39	37.7 ± 2.21	−2.199	.02*	1.34	4.77	14.1	.002* (.45)
		C	34.8 ± 5.37	36 ± 5.75	−2.264	.02*				
	Mobility	E	37.3 ± 2.21	34.7 ± 9.97	−.431	.66	−.94	3.8	.79	.38 (.04)
		C	37.4 ± 2.17	37.5 ± 1.9	−.447	.65				
	Hand function	E	11.5 ± 4.24	16 ± 3.6	−2.821	.005*	−.74	1.58	.58	.45 (.03)
		C	14.3 ± 4.0	18.1 ± 4.1	−2.842	.004*				
	Memory	E	28.2 ± 2.7	28.5 ± 2.32	−1.732	.083	−.42	.62	.16	.69 (.17)
		C	28.2 ± 2.14	28.1 ± 2.23	−.577	.56				
	Communication	E	30.6 ± 2.22	30.5 ± 1.64	.00	1	−.82	.63	.08	.77 (.005)
		C	30.1 ± 2.28	30.2 ± 2.2	−.577	.56				
	Emotion	E	23.2 ± 5.8	34.3 ± 3.33	−2.81	.005*	2.56	7.56	18.29	.001* (.59)
		C	29 ± 3.1	29.6 ± 3.5	−2.558	.07				
	Participant	E	9.9 ± 1.9	15.9 ± 4.28	−2.81	.005*	1.8	6.2	15.19	.001* (.47)
		C	13.1 ± 3.41	14.4 ± 3.56	−1.841	.06				
ARAT (score)	Grasp	E	9.3 ± 3.86	11.0 ± 3.52	02.701	.007*	−.62	.67	.007	.93 (.00)
		C	10.10 ± 4.17	11.7 ± 3.88	−2.889	.004*				
	Grip	E	5.9 ± 1.8	6.4 ± 1.95	−2.236	.025*	−.40	.54	.08	.77 (.005)
		C	6.3 ± 2.6	6.7 ± 2.3	−2	.046*				
	Pinch	E	4.0 ± 2.9	4.2 ± 3.11	−1.414	.15	−.35	.43	.04	.83 (.034)
		C	5.0 ± 3.71	5.1 ± 3.78	−1	.31				
	Gross movement	E	4.9 ± 1.6	6.2 ± 1.5	−2.877	.004*	.50	1.71	14.84	.001* (.46)
		C	4.3 ± 1.8	4.7 ± 2.05	−2	.046*				
Y-BAT (score)	Quality of performance	E	48.8 ± 10.4	55.8 ± 8.96	−2.812	.005*	−.57	2.71	1.88	.188 (.10)
		C	51.2 ± 11.82	57 ± 12.13	−2.816	.005*				
	Satisfaction	E	39.8 ± 7.67	45.4 ± 6.91	−2.689	.007*	1.77	7.00	12.57	.002* (.42)
		C	41.7 ± 9.86	42.8 ± 10.27	−1.93	.05				
Accelerometer (m/s^2)	Use of unaffected side	E	65868.34 ± 7557.41	57631.35 ± 6512.57	−2.803	.005*	−7665.12	1332.69	2.2	.15 (.11)
		C	63233.45 ± 6366.28	58802.73 ± 7980.22	−2.803	.005*				
	Use of affected side	E	31493.07 ± 4452.21	36536.01 ± 5293.68	−2.803	.005*	311.75	3497.65	6.36	.02* (.27)
		C	32357.43 ± 3017.59	35519.01 ± 2791.82	−2.803	.005*				

Abbreviations: ARAT, Action Research Arm Test; C, control group (n = 10); COPM, Canadian Occupational Performance Measure; E, experimental group (n = 10); SD, standard deviation; SIS, Stroke Impact Scale; Y-BAT, Yonsei-Bilateral Activity Test.

Values are expressed as mean ± standard deviation.

*$P < .05$.

**$P < .001$.

psychosocial items such as satisfaction, emotion control, and participation. These psychosocial factors are considered to have resulted in improvement of upper extremity function and improvement of performance. Occupation is a collection of valuable and meaningful activities for an individual,[28] and performing it means participating to a meaningful activity that one chose for oneself with motives.[21] It was reported that this course of treatment procedure where patients select the desired occupation and to play the major role helps both therapist and patient altogether to recognize the problem, increases satisfaction and participation, and motivates active participation thereby improving performance.[29] Occupation-based intervention is the therapeutic use of patient-initiated, direct involvement in activities,[3] which allows the subject to participate more actively by setting its own treatment goals. Such voluntary and active training participation encourages motor learning and therefore is reported as more effective in functional recovery than does task-oriented training.[21] Previous studies have also reported that occupation-based intervention is more effective in functional recovery of the affected side in regular training,[1,30] and this is similar to the results of this study.

This study measured effect size using eta-squared (η^2) value to clarify the effectiveness of the occupation-based bilateral upper extremity training. In this study, psychosocial (such as satisfaction, emotion control, and participation [η^2 range: .42-.72]) and upper extremity function area (such as performance, strength, ADL and IADL, gross movement, use of affected side [η^2 range: .27-.46]) showed a large effect size between groups. According to Cohen, effect size assessed in terms of η^2 is considered small effect for $\eta^2 < .01$, medium effect for $.01 < \eta^2 < .06$, and large effect for $\eta^2 > .14$.[31] While the *P*value representing statistical significance provides only a dichotomous judgment as to how rare it occurs, the effect size has the advantage of being able to quantify the difference between the groups to be compared in the actual observed data.[32] As shown in this study, the statistical significance and a large effect size between the 2 groups in the psychosocial and upper extremity functional areas may be a valid basis for demonstrating the effectiveness of the occupation-based bilateral upper extremity training.

The occupation-based bilateral upper extremity training in medical setting protocol includes 3 factors of occupation-based intervention. Occupation intervention gives intervention to the client to successfully perform one's meaningful occupation in a real-life environment. Here, meaningful occupation refers to an activity that the client chose with motive with its execution being habitual for its regular and repetitive character.[33] Such an occupation-based intervention includes 3 factors. First is motivation, meaning letting client choose the activity or play the central role in the activity, which improves participation of the client throughout lifetimes.[34] Second is the habitual character of the occupation performed. When the client takes on the intervention and training occupation, it is performed in a repetitive and regular manner. Such repetition in movement is vital as it triggers synchronization of the cranial nerve circuit, and ultimately efficient brain usage.[35] The last factor is the setting. The intervention must be done in the most realistic environment possible. Environment causes the change in brain neurons as to thickening brain cortex, which is reported that such neurological change triggers improvement and enhancement in performance.[36] In this study, our group confirmed the effectiveness of 3-factor and hospital-based occupation-based bilateral upper extremity training protocol. Our group used COPM so the patients could determine the desiring daily task, necessary items, and expectation and used them for intervention. This method gave motivation that triggered voluntary cognitive activity along with positive mood that increased participation. Two or 3 tasks selected through COPM were performed for 4 weeks repetitively, and its repetitive motor skills acquisition led to functional recovery of the affected side, possibly from the structural change in the cerebral cortex directing motor learning. Also, by using actual, real-life items, tools and equipment for the training, our group made it as much as possible to render realistic environment thereby meeting the third factor, environment, and setting a basis for future occupation-based intervention to be implemented in the hospital.

The clinical significance of this study is that this study demonstrated the effectiveness and usefulness of the training in the actual hospital setting, occupational therapy room, in improving upper extremity function and psychosocial factors. Korean domestic occupational therapy is mainly conducted in the hospital, and there are hardly any hospitals that meaningfully deliver occupational therapy due to lack of treatment time and environmental difficulties (equipment or space). This study, however, made it possible to safely and easily implement occupational task in the medical setting such as care-room and hospital rooms by considering patients personal and environmental aspects. Also, this study demonstrates cost effective and efficient by allowing the use of actual equipment, tools, and items that patients previously used. This renders more realistic setting for the occupation selected by the patients. Our group also followed detailed and professional, bilateral upper extremity protocol by occupational therapy professionals, suggesting more effective treatment is possible for patients with hemiplegia to train bilateral upper extremity.

The limitation of this study lies in the number of subjects and lack of previous research; therefore, it is difficult to generalize our findings. In addition, this study tried to reduce the bias in the experiment by assigning the subjects through random assignment so that there is no certain principle, but there was a possibility that the observer bias occurred because it was performed by single blind. In the future, double-blind studies involving large numbers

of subjects will be needed to eliminate the subjective bias of the experimenter and subjects. Additionally, the study of cerebral cortex restructuring or Eletroencephalogram (EEG) signal from the training should be combined as the neurological investigation would set a concrete basis for occupation-based bilateral upper extremity training.

Conflicts of Interest

The authors do not have any conflicts of interest to declare.

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