Action Observation Therapy Combined with upper Limb Training Device of upper Extremity Function in Elderly

Phoondharick Iaopanich[1] Pakaratee Chaiyawat[2] Jarugool Tretriluxana[3] Zeng Lertmanorat[4]

Abstract

This study was a randomized trial which aim to study the effect and retention of action observation therapy with and without concept of mirror neuron combined with upper limb training device program of upper extremity function in elderly. Twenty elderly participants were classified into 2 groups. First, ten participants (intervention group) were received action observation therapy for 6 minute , following by using upper limb training device for 1 hour. The other group of ten participants (control group) were received shame therapy for 6 minute, following by using upper limb training device for 1 hour. At the baseline, post- training, 1 day and 1 week later at the end of intervention, the assessment was conducted as following; Wolf Motor Function Test (lift pencil, flip card, lift paper clip) and brief self - efficacy of Accelerated Skill Acquisition Program. There was no significant difference between group at baseline. There were statistically significant difference in lifting pencil (p=0.005 in intervention group, p=0.009 in control group), lifting paper clip (p=0.005 in intervention group, p=0.015 in control group) and flipping card (p=0.037 in intervention group, p=0.005 in control group) after training. There were statistically significant difference in lifting pencil (p=0.041, p=0.028) and lifting paper clip (p=0.014, p=0.010) between groups for retention. The finding suggest that action observation therapy is a desirable first before combined with upper limb training, it can be useful more than upper limb training without action observation therapy.

Keywords: Action observation, Mirror neuron, Upper limb training device, Elderly

[1] M.Sc., Faculty of Physical Therapy, Mahidol University, phoondharick.j@gmail.com

[2] Assistant Professor Dr., Faculty of Physical Therapy, Mahidol University, pakaratee.cha@mahidol.ac.th

[3] Assistant Professor Dr., Faculty of Physical Therapy, Mahidol University, Jarugool.tre@mahidol.ac.th

[4] Assistant Professor Dr., Faculty of Engineering, Mahidol University, zengzeng@hotmail.com

Introduction

Increasing of elderly population is occurred around the world, causing of people increasing with age while decreasing of birth rate. The number of elderly population was 12.3% from all of the world in 2015 and it will rise to 22% in 2050 (WHO, 2015). The national statiscally official of Thailand revealed that the number of elderly population was 12.2% in 2011 and it was increased to 14.9% in 2014, it was rapidly rising and it trends to rise to almost 25% in 2040 (The national statiscally official of Thailand, 2014).

Becoming to the elderly, there are physiological changes which bring to be degeneration, including of physical, psychological and social. Especially, we clearly see in nervous system. Neuromuscular change is the main factor for declining motor control which lead to be insufficient motor performance (Seidler, 2010, pp. 721-733), causing of degenerative of central nervous system in the part of disruption of white matter that lead to reduce connectivity or coordination of the brain (Ni, 2015, pp. 301-303). It is the risk factor to be poor quality of life and reduce or slowness to perform activity daily of living. In everyday life, all of task or activity daily of living (ADL) is almost required the upper extremity movement, so improving upper extremity function is important aspect to maintain ADL, it associates with the ability to perform ADL (Seidler, 2010, pp. 721-733.).

Action observation is observing action of another person to learn a new movement in form of video, it works via mirror neuron activation in the brain to promote functional recovery and facilitate in motor system (Zhu, 2015, pp. 279-282). Accelerated Skill Acquisition Program (ASAP) is patient-centered motivational enhancement which combined task specific and skill-based/impairment-mitigating training (Murray, 1987). The upper limb training device is the device for activating upper extremity function via video game which be suitable for elderly in Thai culture .

Rakkamon et al (2014) studied action observation based on mirror neuron concept in term of upper extremity function, conducting in sub-acute stroke patients, the result showed that the sub-acute stroke patients who receive action observation therapy were significantly improved upper extremity function within the first 4 weeks. Zhu et al (2015, pp. 279-282) studied the effect of action observation in stroke patients, the result showed that the patients in experimental group who receive action observation thrapy had significantly upper extremity function improvement more than control group. Cornelius et al (2009) studied upper limb training in elderly people by using video game, the result revealed that the upper limb training through video game had the immediate effect, it could improve the coordination capabilities and encourage to move arm .

To our knowledge, there has been no studies about action observation in Thai elderly. Hence, the researcher would like to study about the effect of action observation therapy combined with upper limb

training device program of upper extremity function in elderly and we would like to know how long the effect is lasting for at least (retention).

Purposes of the study

1. To compare before and after training , the effects and retention of action observation therapy with and without concepts of mirror neurons combined with upper limb training device program group of upper extremity functions in elderly, measuring by Wolf Motor Function Test and brief self efficacy of Accelerated Skill Acquisition Program.

2. To compare between groups the effects and retention of action observation therapy with and without concepts of mirror neurons combined with upper limb training device program group of upper extremity functions in elderly, measuring by Wolf Motor Function Test and brief self efficacy of Accelerated Skill Acquisition Program.

Hypothesis of the study

Movement time of upper extremity function between action observation therapy with concept of mirror neuron combined with upper limb training device program group and action observation therapy without concept of mirror neuron combined with upper limb training device program group in elderly were different.

Methods

This study was a double-blind (assessor and participants) experimental study. Twenty elderly who were in salaya community in Nakhon Pathom were recruited by face to face. This study was approved by Mahidol University Central Institutional Review Board (MU-CIRB).

Inclusion criteria were: 1).Elderly who were 70-79 years of age; 2).Able to act according to the instruction; 3). Having normal vision and hearing; 4).Able to sit continuously at least 1 hour; 5). Elderly who were willingness to participate and ability to provide informed consent. Exclusion criteria were: 1).Elderly with cognitive impairment (Mini Mental State Examination (MMSE) , Montreal Cognitive Assessment (MOCA)); 2).Elderly with neurological problem and sensation problem; 3).Elderly with musculoskeletal problem that limited movement; 4).Unable to control blood pressure, severe heart symptom; 5).Elderly with severe depression (Hospital Anxiety and Depression Scale Evaluation (HADs)); 6).Having severe pain of upper extremity (pain score≥7) measured by visual analog scale (VAS).

Sample size calculation

The calculation method for sample size calculation is formular calculation:

$$n = \left[\frac{(Z_{\alpha/2} + Z_{\beta})\sigma}{\Delta}\right]^2$$

n = Sample size per group

α = type I error = 0.05

Z α/2 = 1.96 (when the confidence equal to 95 %)

β = type II error = 0.05

Zβ = 1.645

Δ = The difference of mean from baseline and post - treatment

σ = Standard deviation of mean difference

The sample size per group in this study (n) = 10

Instruments

1. Video

1.1 A video of picking an small objects for action observation therapy with concept of mirror neuron.

1.2 A video of natural land scape for action observation therapy without concept of mirror neuron.

2. Tools and questionnaire for evaluation of the following topics

2.1 Mini Mental State Examination (cognition and dementia screening for inclusion criteria)

2.2 The Montreal Cognitive Assessment (MoCA) (cognition and dementia screening for inclusion criteria

2.3 Hospital Anxiety and Depression Scale (anxiety and depression screening for inclusion criteria)

2.4 Edinburgh handedness questionnaire (Handedness)

2.5 Visual rating scale (Pain screening for inclusion criteria)

2.6 Wolf motor function test (movement time at baseline and post training program)

2.7 Brief self efficacy of Accelerated Skill Acquisition Program (ASAP)

3. Upper limb training device

This device is worked by computer programe through visual stimulation, hearing, touching by hand and decision.

The elderly eligible for inclusion were divided in to experimental and control groups based on random block allocation. After that they would be evaluated according to the following research dependent variable for baseline:

1. Wolf Motor Function Test (movement time)

To test of upper limb function to perform each activity in term of time, it was included of 3 activities as following

1. Lift pencil
2. Flip card
3. Lift paper clip

2. Brief self- efficacy of Accelerated Skill Acquisition Program

This is a self – efficacy for upper extremity function which evaluated by participants. The score was ranged from 0-10 by 10 being the most confident arm performance and 0 being the worst arm performance. The researcher have asked participants what score they would give them self and why.

Experimental group

- Action observation therapy combined with upper limb training device

The participants were received action observation therapy in a form of video "picking small object" for 6 minute. After that they were asked to train upper extremity function by upper limb training device for 1 hour. At the end of intervention the researcher would assessed Wolf Motor Function Test and brief self- efficacy of Accelerated Skill Acquisition Program for immediate effect.

Control group

- Action observation therapy without concept of mirror neuron combined with upper limb training device

The participants were asked to observe the landscape of display video for 6 minutes. After that they were asked to train upper extremity function by upper limb training device for 1 hour. At the end of intervention the researcher would assessed by Wolf Motor Function Test and brief self-efficacy of Accelerated Skill Acquisition Program for immediate effect.

For retention test, the participants in both group would be reassessed one day later and one week later. The researcher would assess Wolf Motor Function Test and brief self efficacy of Accelerated Skill Acquisition Program.

Statistical analysis: Kolmogorov-Smirnov test was used to test the normal distribution. Data were analyzed using Mann-Whitney U-test to compare movement time and brief self- efficacy score between two groups, Willcoxon test for within group. Data were analyzed using SPSS . The level of significance set at P value ≤ 0.05.

Result

1. Characteristics of participants

Demographic characteristics of the study participants were shown in Table 1 with the comparison of baseline characteristics including of age, MMSE, MOCA, HADs, and VAS were no significant difference between group.

Table 1 Characteristics of participants

Group	Control Group (n=10)	Intervention Group (n=10)	p-value
	Mean (SD)	Mean (SD)	
No. of patients	10	10	
Age (years)	75.9 (2.88)	74.3 (4.19)	0.513
MMSE (scores)	27.9 (2.60)	28.3 (2.05)	0.75
MOCA (scores)	26.0 (1.24)	26.4 (0.96)	0.236
HADs (scale)	2.4 (1.89)	1.60 (1.07)	0.347
VAS (scale)	0.5 (0.97)	0 (0)	0.068

Significance difference (p-value < 0.05)

2. Comparison of Wolf Motor Function Test in baseline and post training within group

Movement time of Wolf Motor Function Test (lift pencil, flip card, lift paper clip) in baseline and post training were shown in Table 2.1 (control group) and Table 2.2 (intervention group). Table 2.1 was shown comparison of Wolf Motor Function Test in baseline and post training in control group, the result showed significant difference in lifting pencil, lifting paper clip and flipping card. Table 2.2 was shown in intervention group, the result also showed significant difference in lifting pencil, lifting paper clip and flipping card. Moreover, it was significantly better in the intervention group compared to the control group.

Table 2.1 Comparison of Wolf Motor Function Test in baseline and post training in control group

Movement time of Wolf Motor Function Test	Mean(SD)		
	Baseline	Post training	p-value
Lift pencil	1.67(0.53)	1.45(0.47)	*0.009
Flip card	6.23(1.93)	4.86(1.34)	*0.005
Lift paper clip	1.93(0.59)	1.71(0.61)	*0.015

*significance difference (p-value < 0.05)

Table 2.2 Comparison of Wolf Motor Function Test in baseline and post training in intervention group

Movement time of Wolf Motor Function Test	Mean(SD)		
	Baseline	Post training	p-value
Lift pencil	1.65(0.33)	1.28(0.27)	*0.005
Flip card	4.79(1.17)	4.12(0.83)	*0.037
Lift paper clip	1.95(0.50)	1.47(0.42)	*0.005

*significance difference (p-value < 0.05)

3. Comparison of Wolf Motor Function Test in baseline, post training, one day later and one week later between control and intervention group

Movement time of Wolf Motor Function Test(lift pencil, flip card, lift paper clip) in baseline, post training, one day later at the end of intervention and one week later at the end of intervention between control and intervention group, it was found that statistically significant in one day later at the end of intervention (lift pencil: p=0.041, lift paper clip: p=0.014) and one week later at the end of intervention (lift pencil : p=0.028, lift paper clip: p=0.010). The results were shown in Table 3.1.

Table 3.1 Comparison of Wolf Motor Function Test in baseline, post training, one day later and one week later between control and intervention group

Movement time of Wolf Motor Function Test	Mean(SD)							
	Baseline	p-value	Post training	p-value	One day later	p-value	One week later	p-value
Lift pencil	1.66(0.43)	0.597	1.37(0.38)	0.384	1.15(0.36)	*0.041	1.09(0.41)	*0.028
Flip card	5.51(1.72)	0.059	4.49(1.15)	0.290	4.30(1.01)	0.273	4.20(1.04)	0.290
Lift paper clip	1.94(0.53)	0.850	1.59(0.52)	0.272	1.38(0.31)	*0.014	1.27(0.37)	*0.010

*significance difference (p-value < 0.05)

Discussion

The upper limb training device was effective for both group, training involving the visual stimulator, decision and which activate primary motor cortex (Jacila, 2016) and encourage to upper limb function (Cornelius, 2009, pp.50-59). However, the elderly who combined action observation therapy (intervention group) was significantly better than control group in term of Wolf Motor function test (lift pencil,lift paper clip), this is because movement time in intervention group decreased more than control group when compared to baseline. The elderly who received action observation therapy, it lead to activate mirror neuron. Mirror neuron are set of neuron which locate in posterior inferior frontal lobe and rostal inferior parietal lobe that represent an observation-execution match mechanism (Pineda, 2009), this is about observation and execution of movement. Action observation therapy is useful to improve upper extremity function via mirror neuron activation (Zhu, 2015, pp. 279-282), Arbib et. al (1992, pp. 153--175) showed that this machanism depend on action understanding, imitation learining of novel complex action and motor imaging, finally, it will send signal to stimulate primary motor cortex. Lee D et. al (2013, pp. 611-614) indicated that action observation therapy is a desirable first for mirror neuron activation before combine with training, they compared the action practice group and the combined action observation-action practice group for observation drinking behavior function immediately after experiment and one week later, the result revealed that the number of drinking motion had increase the most in the combined action observation-action practice group.

Although the result of this study was not statistically significant in term of brief self- efficacy of ASAP both between and within group, However, the change score of brief self- efficacy of ASAP in intervention group was increased for some participants, that means some participants in intervention

group may have motivation better than control group, the previous study suggested that the learner's self-efficacy was enhanced by observational learning (Murray, 1987).

For between group, the result was not statistically significant in immediately after training but significantly different for retention test (one day later, one week later) in the part of lifting pencil and lifting paper clip. This similar to Lee's study, they studied about drinking behavior in stroke patients, measuring by the number of drinking motion, the result showed that the number of drinking motion was increased most in the combination of action observation and action training group in immediately after experiment and one week later (Lee, 2013, pp. 611-614). It may indicate that the effect of intervention is lasting for at least one week.

This study found significantly improvement on lifting pencil and lifting paper clip but not found on flipping card because the sequence movement in form of video for action observation and game on upper limb training device were similar to lifting pencil and lifting paper clip. Sale P et al (2014) trained drink tasked combined with other ADL, the measurement was box and block test which similar to actions of drinking, the result showed significantly different. Lee et al (2013, pp. 611-614) trained drinking task and measured by the number of drinking motion, in this study, the task and assessment were similarity, the result showed improvement of either action observation, action training or combination. These associated with task specificity.

Limitation

There are limitation for this study. Firstly, the participants could not practice with out television. Secondly, the participants could not take part in this study if they had vision problem.

Suggestion

Action observation therapy based on concept of mirror neuron combine with upper limb training device can be alternative for physical therapist to use as rehabilitation. According to this study, it indicates that the action observation therapy combined with upper limb training device for immediate effect can rehab upper extremity function and it is lasting for at least 1 week after intervention in elderly. The researcher suggest that physical therapist can apply action observation in elderly with other characteristics such as elderly with mild cognitive impairment or elderly wth gait problem.

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