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Efficacy of Action Observation for Upper Limb Motor Deficit in Acute Stroke Participants

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Action Observation (AO) is a multisensory approach encompassing motor, somatosensory and cognitive rehabilitation. Several Studies have proved the effects of action observation on recovery of motor functions in chronic stroke survivors. However, the effect of action observation strategy on acute stroke participants remains unclear. The objective of this study was to find out the effectiveness of action observation to improve upper limb function in acute stroke. **Methods:** 28 acute stoke participants were selected based on inclusion and exclusion criteria and randomly assigned into two groups based on computer generated randomization. Action observation training group (AO) received action observation training and conventional group

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received conventional physiotherapy. Both the groups received 45 minutes session per day for the total duration of 10 days.

Results: Upper limb functions were measured using Fugl Myer upper limb component (FMA) and action research arm test (ARAT)at the baseline and after the intervention. Compared with the conventional training group, AO group showed significant improvement in ARAT but no significant difference between the groups in FMA.

Conclusion: In conclusion Action observation treatment may become a useful strategy in rehabilitation of acute stroke participants.

Keywords: Action observation; acute stroke; upper limb motor recovery; motor relearning; mirror neuron system.

1. INTRODUCTION

The National Institute of Neurological disorders and stroke has defined cerebrovascular disease as any disorder in which an area of brain is transiently or permanently affected by ischemia or bleeding or in which one or more blood vessels of the brain is primarily impaired by pathological process [1]. In 2010 stroke was considered the 2nd most common cause of Disability Adjusted Life Years (DALYS) according to the global burden of diseases injuries risk factors study [2].The most common and disabling motor deficit following stroke is the loss of upper limb function. Functional recovery after stroke is known to be influenced by the size, type, and site of brain damage, as well as by the quality and intensity of the rehabilitation intervention. The current views on rehabilitation effectiveness advises to pursue the relearning of basic skills concerned with activities of daily living and to practice activities of daily living intensively in order to optimize the upper limb function [3]. Motor recovery after stroke occurs as a consequence of neural plasticity. A range of neuro rehabilitation techniques aims to facilitate the occurrence of neural plasticity to overcome the functional impairments in affected individuals [3].Over the last few years; several approaches have been tested with respect to their efficacy at promoting hand dexterity recovery after stroke. Among them, task-oriented therapy, robot-assisted rehabilitation, and action observation (AO) were paid the greatest attention for upper limb motor rehabilitation in individual with stroke [4]. AO is considered as a multisensory approach encompassing motor, somatosensory and cognitive rehabilitation [5]. This approach demonstrated an important role in motor recovery of stoke population by activating the mirror neural system (MNS) of the brain [6]. AO isa well-known neurophysiological mechanism by which the brain matches an observed action to its motor function. It consists of a person observing a healthy individual performing a motor task, either on a video [7] or real demonstration [8]. For example, the stroke survivor is instructed to watch a video showing an adult stretching out this hand to hold the jar, bringing the glass to the mouth. After observing the video sequences for a time, the individual is asked to perform the action demonstrated in the video. AO has been applied alone or in association with other practices such as imitation and engagement in physical actions and training of functional activities aimed at stimulating motor relearning. It is hypothesized that the motor area engagement that occurs in real execution of action is the same taking place during observation of this action, and that action observation would therefore induce neural plasticity in individual with stroke promoting activation of the damaged motor circuits. For this reason it is suggested that this mirror neuronal system activation may serve as an alternative means to rearrange damaged, but not completely lost circuits thereby rebuilding voluntary function [3]. There are many literatures proved that AO strategy gives an improvement in recovery of motor function in chronic stroke participants [9]. There is lack of supports available to document the effectiveness of action observation in acute stroke. While action observation appears to result in improved performance, it is still on open question as to prove the effectiveness in complex task. Hence, there is a need to implement this study in acute stroke participants. Therefore the aim of this study is to find the effectiveness of action observation training to improve the upper limb motor function in acute stroke participants.

2. MATERIALS AND METHODS

The present study utilized a quasi-experimental research design. A total of twenty eight acute stroke participants of both genders between the ages of 40 to 60, left middle cerebral artery ischemic stroke with in the period of one month post stroke, those who are medically stable with

able to sit during treatment session, having score of <34 in fugl-meyer scale upper limb component and who gave informed consent to participate in the study were recruited from department of neurological physical therapy, P.S.G Hospitals. Participants with previous history of stoke, mini mental status scale score <24, Psychological disorder, Aphasic patients, participants who are not able to follow the commands, Other neurological disorder, Orthopedic problem that will hinder them from performing the tasks and those who were having visual deficits were excluded from the study. Participants were divided into two groups (AO group and Conventional group) based on computer generated randomization with allocation ratio of 1:1. Patient allocation was concealed by another investigator using closed envelope. AO group(n=14) – Participants were received action observation strategy, conventional group - Participants were received conventional physiotherapy. The total duration of the study is 10 months.

Instrument & tool for data collection: Fugl Meyer Assessment Scale – The upper limb motor function was assessed using Fugl Meyer assessment of motor recovery. This scale has 5 domains, in which only upper limb motor component has been incorporated for use and the total score of this domain is 66. And this scale has a good interrater reliability & validity [10]. Action Research Arm Test - Functional recovery was assessed by the Action Research Arm Test (ARAT). The ARAT consists of 19 tasks which are categorized into 4 domains (grasp, grip, pinch, and gross movement) and the maximum obtainable score is 57.The clinometric properties of ARAT have been well established. The interrater reliability of ARAT was 0.98 [11]. Materials used for assessment were Comb, Glass, Jar, Brush, Bottle, LCD Projector and Laptop.

Intervention: Participants were assessed at baseline using the above mentioned outcome measures before random allocation to intervention. After 10 days of the allotted intervention participants were reassessed using the same outcome measures. The outcome assessor was blinded to group allocation of the participants.

AO Group: This group of participants underwent action observation strategy training using following protocol, in this study 8 different upper limb motor tasks were selected and all these were demonstrated by means of video. The tasks are, 1.Holding a jar, 2.To bring the glass to mouth, 3.To comb the hair, 4.To press the door bell, 5.To open the door handle, 6.To open the drawer, 7.To take tooth brush & clean tooth, 8.To open the bottle.These actions were demonstrated by a normal individual and it was video recorded. Each task was subdivided into 3 or 4 constituent motor acts, each motor act presented for 3 minutes so that total duration of video was 9 to 12 minutes. Participant were instructed to carefully observe the motor act demonstrated in the video for 3 minutes, immediately after the observation they were asked to imitate the motor act with the affected limb for the duration of 3 minutes, same procedure followed for the remaining constituents of the tasks, only one task was trained during each treatment session. The total duration of the session is one hour, the participants were asked to repeat the movement during the remaining time of the session. They underwent 10 days of training program, one session per day. The treatment program took place in a quiet environment, with the participant sitting comfortably in front of the screen in the presence of a physiotherapist. Control group also were given trainingwith the same eight tasks but withoutvideo demonstration and observation of action. Post intervention assessments weretaken using Fugl Meyer assessment and Action Research Arm Test (ARAT) on the 10^{th} day of treatment.

2.1 Statistical Analysis

Data collected from subjects were analyzed using paired‘t’ test to measure changes between the pretest and posttest values of outcome measures within the group. Independent‘t’ test was used to measure difference between the groups. The significant value was set at $P<0.05$.

3. RESULTS

Based on Table 2, the mean difference ± standard deviation of AO group was found to be 8.92 ± 10.29, the ‘t’ value was 3.246 which was greater than the table value 2.160 at $p <0.05$. In Conventional group the mean difference ± standard deviation was found to be 2.50 ± 9.02, the ‘t’ value was 1.037 which was less than the table value 2 .160 at $p <0.05$.

Table 1. Baseline participant characteristics

Variables	AO group (n=14)	conventional group (n=14)
Gender (%)	Male 11(78.6%)	Male 8(57.2%)
	Female 3(21.4%)	Female 6(42.8%)
Age (years)	52.42±6.14	53.71±7.01
Post Stroke duration (day)	5.79±4.54	7.5±4.09
MMSE	24.21±0.42;24	24.35± 0.65;24.3
Fugl Meyer (UE)	6.85±4.3;6	8.5±7.9;1
ARAT	1.3±3.02;5.50	5.57±9.65;1.5

Data given as mean ± standard deviation; median

Table 2. Within group analysis for FMA

Groups	Mean ± Standard Deviation	't' value	'p' value
AO Group			
Pre-intervention	6.86 ± 4.33		
Post-intervention	15.78 ± 11.93	3.246	P<0.05
Conventional group			
Pre intervention	10.71 ± 9.29		P<0.05
Post intervention	13.21 ± 10.44	1.037	

Table 3. Within group analysis for ARAT

Groups	Mean ± Standard deviation	't' value	'p' value
AO group			
Pre intervention	1.36 ± 3.03		
Post intervention	15.86 ± 17.13	3.501	P<0.05
Conventional group			
Pre intervention	4.93± 9.85		
Post intervention	9.07± 15.27	2.125	P<0.05

Table 4. Between group analysis of outcome measures

Outcome measures	't' value	'p' value
FMA	1.758	P <0.05
ARAT	2.263	P <0.05

Based on Table 3, the mean difference ± standard deviation of AO group was found to be 14.50 ± 15.49, the 't' value was 3.501 which was greater than the table value 2.160 at p <0.05. In Conventional group the mean difference ± standard deviation was found to be 4.14 ± 7.29,the 't' value was 2.125 which was less than the table value 2 .160 at p <0.05.

The independent 't' test was performed between AO group and Conventional group to analyze the significance difference between the two groups. Between groups analysis of FMA score did not showed significant difference, the calculated 't' value was 1.758,which was lesser than the table of 2.056 at p< 0.05.Between group analysis of ARAT score showed significant difference, the calculated 't' value was 2.263 which was greater than table value of 2.056 at p<0.05.

4. DISCUSSION

The aim of this study was to find the effectiveness of action observation training to improve the upper limb motor function in acute stroke. A total of 28 participants those who fulfilled the selection criteria were included in this study. They were randomly assigned in to action observation group (AO) or conventional group. Outcome of this study was measured using two valid tools namely Fugl Meyer Assessment scale (FMA) and Action Research Arm Test (ARAT), and the total duration of the intervention was 10 days. The distribution of study participants (N=28) by age, gender, and main clinical characteristics did not significantly differ between both the groups.

All participants in AO group showed significant improvement in both the outcome measures in

within group analysis whereas in Conventional group the pre and post intervention mean difference was not statistically significant. When comparing AO group and conventional group in Independent t test the statistical significant difference was present only in ARAT outcome measure but not in FMA outcome measures ($P<0.05$).

The results show that the relearning of motor skills occurs in both conventional and AO groups, but the improvement was not statistically significant in conventional group. In the present study acute stroke participants were asked to observe everyday life actions, of which they had motor competence and experience, but that had to be trained or relearned because of the vascular accident [12]. There sults of the study clearly support the positive effect of action observation therapy, especially because we could not get significant additional effect of the present treatment in the conventional group participants. More importantly, in conventional group, which performed the same amount of tasks, but without the action observation component, the therapy effects were little weaker. The participants who were in acute stage of stroke, during action observation therapy session felt some difficulties to observe the same video throughout the session and 3 of them felt that the video observation of the known activities was the waste of time, but on repeated explanation they were made to watch throughout the session. This might affect result of the study, so the future studies should take in account for this type implementation of action observation therapy.

This study is in accordance with the findings of [13], which state that the transfer of our findings from basic sciences (MNS and action observation) to clinical rehabilitation makes our approach innovative. The focus on the very early phase of stroke recovery makes this research relevant to clinical practice although, spontaneous changes could account for some gains.

Motor recovery", represented by the subsequent stages of movement in and out of synergy patterns, as measured by the FMA scale, from "functional recovery" [14], which is more at the disability level, as measured by the ARAT test [15] but in our study the participants were improved in both outcome measures which means both motor and functional recovery was presented, and also little more improvement present in functional recovery of the upper limb than the motor recovery because the tasks were very functional that was related to our daily life activities.

A study found that during the observation of piano playing there is a stronger activation of themirror neuron system in professional pianists than in musically naive controls [16]. The role of action observation and the mirror neuron system in acquiring new motor skills complements these findings. For example, observational simple thumb movement can induce a new sensorimotor memory Trace [17], even in elderly individuals who appear to have reduced abilities to acquire new motor memory traces [18].

In an event related fMRI study found that in musically naive participants required to learn some guitar accords following a model, the mirror neuron system was active from the observation of the model till the actual execution of the observed accord. These findings clearly support the mirror neuron system has been shown to be involved in imitation learning and the specific role of the mirror neuron system in the acquisition of new motor skills [19]. Current study also utilizes the action observation using video clips may enhance the activation of new motor memory traces and mirror neuron system. This also could be a possible underlying mechanism for improved functional recovery.

In this study during imitation phase participants were provided with the objects used in the video clips in order to make the execution as close as possible to everyday situation. Objects automatically recruit the most useful motor programs to act upon them thus further contributing to the recruitment of motor system.

5. CONCLUSION

In conclusion, the present study suggests that action observation treatment could be considered as a good addition in rehabilitative approach in acute stroke participants along with traditional treatment. On the whole, the simplicity of treatment, the lack of adverse effect and the positive preliminary results supports the use of this treatment in association with physical therapy management. Absence of significant difference in the FMA between group analyses does not allow us to draw definitive considerations about the action observation training in upper limb motor recovery.

6. LIMITATIONS

The interpretation of group differences was only based on clinical measures and this methodological choice represents the main limitation of this research and also small sample size. Future studies should combine electrophysiological recording or functional neuroimaging data acquired will hopefully provide a more comprehensive understanding ofhow action observation modulates the brain activity and the recovery of motor performance and long term follow up should be done to determine the carry over effects of treatment.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

Ethical Clearance for this study was got approved from the Institutional Human Ethical Committee (IHEC). The study was approved by the institutional human ethical committee (reference number 15/091).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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