

EFFECT OF ACTION OBSERVATION THERAPY ON IMPROVING UPPER LIMB FUNCTIONS IN ACUTE STROKE PATIENTS: AN EXPERIMENTAL STUDY

Physiotherapy

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ABSTRACT

BACKGROUND & PURPOSE: The most common disabling motor deficit following stroke is the loss of upper limb function. 5-20% of patients presenting an upper limb paralysis at onset may improve the motor impairment overtime. Action observation training is a novel rehabilitation approach exploiting this mirror mechanism and its potential role in motor learning for motor recovery. Aim of this study was to examine the effects of action observation therapy on upper limb functions in acute stroke patients.

METHODOLOGY: Stroke survivors (N= 50) were consecutively recruited 22 days (± 5) after a first-ever stroke and participants watched video footage of daily routine tasks (actions). Each action based on some relevant ADLs motor sequence display in order of ascending difficulty and lasting for 3 minutes and therapist prompted the patient to perform the same movement for 2 minutes. At the end of each sequence, patients were given conventional physiotherapy and AOT 1 hour daily for 5 days/week for 4 weeks.

RESULTS: Upper Limb part of FMA, Modified Ashworth Scale scores & nine-hole peg test were taken at baseline and after 4 weeks as outcome measure. Paired 't' test and Wilcoxon's signed-rank has been used for analysis of Fugl Meyer scale, Modified Ashworth Scale and Nine-hole peg pre and post treatment scores respectively (p value<0.05) So, a statistically significant difference was found after treatment for all variables.

CONCLUSION: The finding of this study is suggesting that Action observation training programs contribute to improve motor recovery in acute stroke patients.

KEYWORDS

Acute stroke, Action observation Therapy, upper limb

INTRODUCTION

A stroke is caused by a disruption of the blood supply to the brain that leads to damage of brain tissue. Motor impairment is common after stroke. One study concluded that the Common impairments are weakness (upper limb, 77.4%), urinary incontinence (48.2%), impaired consciousness (44.7%), dysphagia (44.7%), and impaired cognition (43.9%).⁽¹⁾ In the acute phase, approximately 70-80% of the patients have impaired upper limb function, only 5-20% demonstrate full functional recovery.^(2, 3, 4) By the middle of this century, motor learning had been established as a specialized area of study. Feedback can enhance motor learning in healthy subjects. It can be classified as either 'intrinsic' or 'extrinsic'. Feedback is commonly given verbally by the trainer, or visually (e.g., demonstration, video), or by manual assistance.⁽⁵⁾ Mei-Hong Zhu, Mei-Fang Shi, Jin -Mei et.al conducted study on effects of action observation therapy on upper limb function and activities of daily living in Sixty-one stroke patients, they were randomly divided into two groups; control group received routine rehabilitation treatment, whereas experimental group additionally received eight weeks of action observation therapy for 30 min, six times per week. They were concluded that Action observation therapy significantly improves upper extremity motor function and performance of activities of daily living, and alleviates upper limb spasticity in patients with stroke.⁽⁶⁾ Action observation is a new rehabilitation training method that brings about improvements in actual skills through the activation of the brain region obtained by observing, imitating and practicing others actions.⁽⁷⁾ The neurologic mechanism of this action observation training is based on the discovery of the mirror neuron system, in which the premotor area and the parietal lobe in the brain region are known to be activated not only when actions are conducted first hand, but also when the same actions are observed.⁽⁷⁾⁽⁸⁾

There were various studies conducted regarding the effectiveness of AOT in sub-acute and chronic stroke but literature on the use of action observation for recovery of upper limb function in acute stroke is limited. Hence the purpose of the present study was to evaluate and examine the effects of action observation therapy on upper limb functions and dexterity recovery in acute stroke patients.

METHODS:

Participants:

Pre to Post-test Experimental study design and convenient sampling method were used. Fifty stroke patients were recruited from OPD and IPD of Parul sevashram hospital, where they received post-stroke rehabilitation treatments. Participants were acquainted with the study's procedures, and written informed consent was obtained. The local ethical committee of the Parul University of Vadodara approved the study. Before inclusion, the baseline assessment included the neuropsychological assessment (Mini-Mental State Examination) and functional evaluation.

INCLUSION CRITERIA:

Subjects were selected for the study based the following criteria.

- 1) Hemi paresis resulting from an ischemic or hemorrhagic stroke, with in a 4 week after stroke onset.
- 2) Both male and female gender.
- 3) Patients who presented with a first ever stroke without previous neurological pathologies.
- 4) Score at least 23 points or more than that in mini mental scale examination.
- 5) No visual field defect.
- 6) Patient is able to sit with or without support up to the time of treatment

EXCLUSION CRITERIA:

- 1) Glasgow Coma Scale score<15, unable to express themselves in speech or to comprehend verbal or written information.
- 2) Prominent major depression, sever psychiatric disease.
- 3) History of CVA more than one time or bilateral CVA at a time.
- 4) Severe form of neglect and Anosognosia.
- 5) Another form of musculoskeletal disorder or limitation of joint motion and Myopathy.
- 6) Severe sensory deficits in the paretic upper limb.
- 7) History or present illnesses of sever cardio-respiratory disorders, epilepsy and severe pain.

Procedure:

The participants were asked to sit a distance 2 m from a color television or laptop screen set and place their arm comfortably on table with or without support according to patient's comfort level in quite room. A set of video clips was produced, displaying object related movements of the hand or arm during typical activities of daily living. We chose 20 daily activities during action observation therapy, they are 1) Grasping and moving an object in horizontal plane.2) Grasping and moving an object in vertical plane.3) To clean the table.4) To take a basket and shifting it.5) To take and eat an apple.6) Opening and closing a jar. 7) To take and to move a bottle.8) To take and open a box.9) To open and close the drawer.10) To comb the hair.11) To take and to bring the cup to mouth.12) To take a paper and thrown in the trash.13) To take a magazine and read it.14) To take a key and open a door.15) To take and to try use a cut.16) Writing with pen.17) Turning pages of book.18) Manipulating the cube with both hands.19) Overhead reaching activity.20) Shirt buttoning and unbuttoning.

The actions were observed from a first-person perspective. Actors in the videos were young nondisabled people, either men or women. Each action consisted of three different meaningful motor sequences displayed in order of ascending difficulty and lasting 3 minutes each. Tasks were based on some relevant ADLs. For example, take and drink a cup of coffee was divided into 3 acts: (1) reach and grasp the handle of the cup with the affected arm and return to the starting point; (2) reach

and grasp the handle of the cup with the affected arm; rise the cup towards the mouth; return to the starting point; (3) reach and grasp the handle of the cup with the affected arm; rise the cup towards the mouth and drink; then, return to the starting point. Motor tasks had varying difficulties in order to fit different degrees of paresis. Over a session, a different action was presented in fixed order according to an increase order of complexity as judged by experimenter. Every day, before starting physical training, patients were asked to carefully watch footages showing two different daily routine tasks under Therapist supervision, each video sequence that was followed by the instruction: "Start to practice now!" The clip was then repeated for another two minutes in which the patient performed the displayed movement with the affected hand, whereas the physical Therapist consistently held high the patient's attention with verbal feedback. There were unimanual and bimanual tasks. Unimanual tasks required the use of only the affected limb. The patient was presented only two tasks per day, starting from the easiest and ending with the most complex action throughout 20 sessions. The patients were asked to perform the observed action with their paretic upper limb at their best convenience, as many times as they could. They received verbal instructions but not physical contact was made by the therapist as follows: "slowly put the hand of your affected arm to the top of your head. You may use your unaffected arm to help guide if needed, "The therapist judged whether patients could accomplish the task themselves or should be assisted in the task of imitating the observed action, Each session was last about 20 min (3 minute sequence observation and 2 minute action performance for 2 motor tasks), along with that at the end of each action imitation performance 5 min rest given to patients, according to convenience of patients. Activities were also changed if the participant improved to the point where they could be completed without difficulty. Prior to session, all participants will receive 30 min of general physical therapy that consist joint range of motion exercise, muscle facilitation techniques and a stretching exercise. The experimental session was conducted over the course of approximately 30mins each time, 5 day a week, for 4 weeks.

Outcome measures

Clinical outcomes were assessed using valid and reliable stroke tools that include all International Classification of Functioning, Disability and Health levels. The upper limb section of the Fugl-Meyer Test (FM) ⁽¹⁹⁾, which is a global evaluation scale for impairment in stroke patients, and the Modified Ashworth Scale-Shoulder, Elbow and wrist, as outcome measure assessing spasticity ⁽¹⁰⁾ and nine hole peg test for dexterity function, were selected as primary outcomes.

Statistical Methods:

Descriptive statistical analysis has been carried out in the present study. Out Come measurements are measured pre and post treatment scores, presented as Mean SD. Paired t test as a parametric have been used for analysis of Fugl Meyer scale because data passed the normality test with $P > 0.05$ and follow Gaussian distribution. Wilcoxon's signed-rank test as a nonparametric have been used to determine changes in Modified Ashworth Scale and Nine hole peg test and post treatment scores.

RESULTS

In study group there were 50 subjects with mean age of 57.42 years and there were 31 males and 19 females were included in the study. When means of scores analysed from pre to post intervention within Group, Table 2,3 and Graph 1 and 2 show that After 4 weeks of Action observation therapy and exercise programme, Fugl Meyer Test mean score

Improvement over time in the shoulder, elbow, and wrist, MAS score could be detected in treatment group. Which showed extremely significant difference within 95% confidence interval, p -value < 0.0001 . A not statistically significant difference found in nine hole peg test score in the group as shown in table 4 and Graph 3.

DISCUSSION

The results of this study had shown that individuals who participated in the treatment program (action observation therapy) experienced greater improvements in upper limb gross motor and dexterity functions.

After stroke, intrinsic feedback systems may be compromised so extrinsic feedback may be even more important for people with Stroke to improve performance. Studies have shown that patients with unilateral stroke are able to learn new motor skills by Instructions or feedback inducing an external focus and they are more effective than

those with an internal focus to improve performance of tasks after stroke by the driving force of reorganization and plasticity. ⁽¹¹⁻¹⁵⁾

Nearly all studies on the recovery of motor function in stroke survivors have found that the most rapid recovery occur during the first few weeks after stroke. In a meta-analysis of 36 clinical trials in stroke rehabilitation ⁽¹⁶⁾ "Ottenbacher and Jannell" noted that early initiation of rehabilitation for stroke patients was related to improve motor and functional outcomes.

Franceschini et.al; similarly used action observation therapy and showed that, compared to control patients who watched videos of daily activities prior to the conventional rehabilitation therapy exhibited greater improvement in motor function and daily activities after four weeks of treatment. ⁽¹⁷⁾ Tracy Cowles et al conducted study on Observation-to-Imitate plus Practice within 31 Days of Stroke and finding of this study suggested that statistically significant improvements from baseline to outcome for ability to voluntarily contract paretic muscle in early phase observation training. ⁽¹⁸⁾ Particularly in this above study they had shown functional tasks which were performed by therapist then patients tried to imitate the therapist's movement, while in present study visual feedback was given by showing videos to the patients so the consistency of functional task perception by patients were maintained throughout treatment period and the chances of subjective error could be diminished. The work of Woodworth (1899) proposed Vision plays a key role in motor control, learning and movement planning as it provides key information that is needed to generate the motor plan and at a cognitive level also plays a key role in the online control of movement. ⁽¹⁹⁻²⁶⁾ Keele and Posner (1968) concluded that the availability of vision during reaching movements did facilitate accuracy and minimum amount of time needed to utilize this information. ⁽²³⁾

Mirror neurons are a unique set of neurons, which are "resonate" in response to the elementary motor acts that form the observed action and represent an "observation-execution matching mechanism". The mirror system activation of premotor cortex and parietal areas are influence motor cortical outputs trans-synaptically, hence shifting motor cortical output excitability and in that each neuron within M1 appears to participate in the projection to multiple muscles and motor actions. ^(27,28) through this mechanism, an observed action is subdivided into its elementary components and coded in motor action sequences. When the action imitated corresponds to an elementary act which one already present in the mirror neuron system, this act can be immediately forwarded to other structures and replicated. During action observation event, activations in the memory processing also noted and the inferior parietal lobule and the posterior part of the inferior frontal gyrus plus the adjacent premotor cortex (mirror neuron circuit), This basic circuit underlying imitation, known to be involved in action understanding, starts to be active during the observation. During pause, the middle frontal gyrus (area 46) plus Structures involved in motor preparation were activated. ⁽²⁹⁾

Roosink and Zijdwind (2010) demonstrated that instructing participants to observe an action with the intention to imitate it later produced MEPs of larger amplitude than when participants were instructed to simply observe an action. ⁽³⁰⁾ The pattern of cortico-spinal modulation matches the muscle recruitment involved in action imitation, that modulation of the agonist and antagonist muscles suggests a change in the balance of inhibition and excitation within the cortical representation of the limb. ^(31,32) Heyes et. al; have proposed that a strengthening of the synaptic connections between sensory and motor neurons, ultimately leading to motor neurons becoming responsive to both sensory and motor information by co-occurrence of action execution with the observation of one's own or others' actions. According to this theory, the mirror response is not strictly tied to the observed action, but could also reflect 'complementary' actions that are consistently paired with the execution of a particular action. ⁽³³⁻³⁵⁾

This study results expand the results on "short-term" plasticity of the motor cortical outputs by revealing that not only functional task oriented repeated motion, but also motion observation which one goal oriented, can exert beneficial effects. Therefore, it is possible that using action observation to activate premotor areas and in turn modulate motor neuronal output may be particularly contributed for the upper limb motor recovery and modulate the tone (Fugl Meyer Score and MAS) in acute stroke patients.

Muscle tone is often considered crucial in governing the recovery of UE motor function⁽³⁶⁾. In the observational study on the recovery of motor function after stroke, Spasticity usually appears days to weeks after the acute event and, often becomes a permanent impairment as shown by electromyography studies.⁽³⁶⁻³⁷⁾ Sommerfeld and colleagues found that muscle tone was associated with the ability to perform motor tasks.⁽³⁸⁾ While Study conducted by Stephanie s. y. au-yeung et.al concluded that muscle tone in the early post stroke period did not predict the recovery of dextrous hand function.⁽³⁹⁾ Thus, according to result of present study the improvement in the tone of the muscle seen at the earlier interventional period but fine dexterity recovery not statistically significant after four week of intervention treatment emphasis on muscle tone should be reviewed if recovery of functional dexterity is the ultimate goal.

The focus on the early phase of stroke recovery is a further innovative feature of this study and makes our research useful to clinical practice, this method may help patients to continue with long-term training schedules, which can reduces the chances of the formation of disuse syndrome, secondary complications, faulty representation of movement Therefore, based on the findings the present study found that there is a statistically significant effect of Action Observation Therapy on hand recovery in rehabilitation of hand function in acute stroke. However, in addition to the proposed neural mechanism underlying the effects of action observation therapy, it is possible that patients' interest and enthusiasm for rehabilitation were enhanced by therapy.

It is recommended for future research to find the long term effect of AO therapy with conventional exercises with follow up , to find the effects of AO therapy in stroke patients with apraxia or neglect with other perceptual disorders and quality of life, to compare the AO therapy with other motor imagery techniques, to find the variable duration and frequency of therapy and exercise parameters to investigate the effect of different exercise regimes.

CONCLUSION

The results of current study demonstrate that supplementation of conventional rehabilitation with action observation therapy for 4 week significantly improves upper limb motor recovery in acute stroke patients Because of its cost effectiveness, it may be recommended as an add-on home-based therapy to improve long term outcome after stroke.

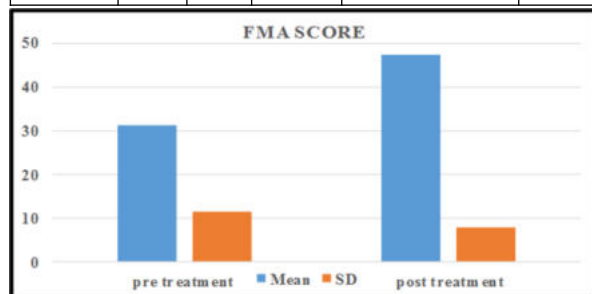
Tables and Graphs

Table1: Demographic and clinical characteristics of study participants (n = 50)

Characteristic	Value
Mean Age $\pm$ Standard Deviation(years)	57.42 $\pm$ 9.3133
Gender No. M/F	31 / 19
Dominant side no. Right/Left	27/23
Side of Lesion No. Right/Left	39/11
Type of CVA No. Ischemic/Haemorrhagic	36/14
MMSE Mean $\pm$ Standard Deviation	26.5 $\pm$ 1.8543
Time between stroke onset and first assessment Mean $\pm$ SD (days)	22.26 $\pm$ 5.9309

Table 2: Comparison of Fugl Meyer Test score pre and post intervention.

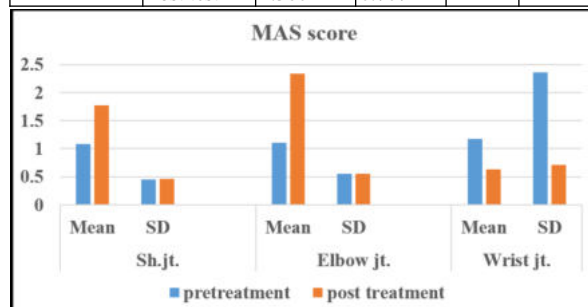
FMA score	Mean	$\pm$ SD	t value	degrees of freedom	P value
Pre test	31.220	11.490	18.882	49	<0.0001
Post test	47.260	7.969			



Graph 1: Comparison of Fugl Meyer Test score pre and post intervention 4th week.

Table 3: Comparison of Modified Ashworth Scale score pre and post intervention 4th week

MAS score		Mean	SD	z value	P value
Shoulder joint	Pre test	1.08	0.447	-5.657	<0.0001
	Post test	1.77	0.459		
Elbow joint	Pre test	1.105	0.558	-6.206	
	Post test	2.340	0.566		
Wrist joint	Pre test	1.180	0.628	-6.120	
	Post test	2.360	0.707		

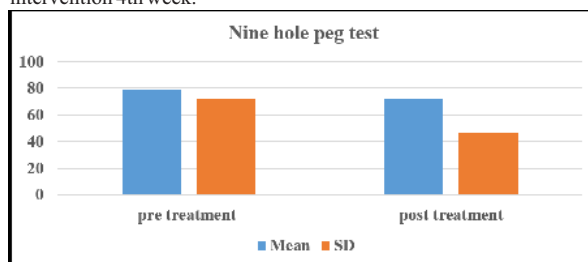


Graph 2: Comparison of Modified Ashworth Scale score pre and post intervention 4th week.

Table 4 : Comparison of Nine Hole Peg Test score pre and post intervention 4th week.

Nine hole peg test score	Mean	SD	z value	P value
Pre test	79.38	72.042	-1.809	= 0.4585
Post test	72.04	46.761		

Graph 3: Comparison of Nine Hole Peg Test score pre and post intervention 4th week.



Images:



Photograph 1: Opening and Closing of bottle lid.



Photograph 2: Holding the pen and writing activity.



Photograph 3: Holding the glass and drinking activity.

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