Original Article

Effect of action observation therapy on daily activities and motor recovery in stroke patients

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ABSTRACT

Objective: To evaluate the effects of action observation therapy, which is based on mirror neuron theory, on upper limb function and activities of daily living in patients with stroke.

Methods: Sixty-one patients with stroke were randomly divided into two groups; those in the control group received routine rehabilitation treatment and nursing, whereas those in the experimental group additionally received eight weeks of action observation therapy for 30 min, six times per week. Patients receiving action observation therapy watched videos depicting a model performing specific motor actions typically performed in daily life before enacting the same actions themselves. All patients were assessed using the Fugl-Meyer assessment, Barthel index and the modified Ashworth scale at baseline and at eight weeks, after treatment.

Results: After the eight weeks of treatment, both groups of patients exhibited significant improvement in all the measurements (all \( p < 0.05 \)). Furthermore, the Fugl–Meyer assessment, Barthel index and modified Ashworth scale scores were significantly higher in the experimental group compared to the control group (all \( p < 0.05 \)).

Conclusion: 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.

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1. Introduction

In China, patients with stroke experience relatively slow and poor rehabilitation of their upper extremity function following hemiparesis. For example, 55–75% of stroke patients have upper limb disorder, and only 38% have partial restoration of upper limb flexibility six months after the stroke [1]. This results in extreme disability in many patients, and severely limits their ability to perform daily activities. Rehabilitation therapy for the recovery of upper extremity function primarily includes constraint-induced movement therapy, traditional
hand function training methods, robot-based auxiliary rehabilitation training, functional electrical stimulation, joint training of both upper limbs and so on. However, such therapies require long-term, high-intensity one-on-one training with the therapist, which can be difficult for the majority of patients to complete.

A new type of rehabilitation therapy, called action observation therapy, has been developed based on the mirror neuron theory [2,3]. Mirror neurons are neurons in the brain that are activated both when an individual executes an action and when he or she observes another perform the same action. The goal of action observation therapy is to promote functional reorganization within the brain of stroke patients via activation of these mirror neurons in order to promote motor function recovery. A European study showed that the performance of daily living activities, upper extremity function and Ashworth score of stroke patients were improved by action observation therapy, thereby demonstrating the effectiveness of mirror neuron activation on functional recovery after stroke [4]. The aim of the present study was to compare the effects of action observation therapy with standard rehabilitation alone on upper extremity function and activities of daily living in hemiplegic patients with stroke in China.

2. Materials and methods

2.1. Patient selection

A total of 70 stroke patients who were hospitalized in our Rehabilitation Medical Centre between January 2013 and June 2014 were recruited for this study. This study was approved by the Hospital Ethics Committee.

Criteria for inclusion were: (1) patients who met the diagnosis for stroke formulated in the 4th National Academic Conference on Cerebrovascular Disease in 1995 [2], and were confirmed as having a stroke upon computed tomography or magnetic resonance imaging [5]; (2) first-episode patients who began rehabilitation therapy within 6 mo, for whom the sitting balance was ≥Level 1, and the Fugl–Meyer assessment (FMA) score was ≥15 for upper extremity motor function; (3) patients with a stable condition; (4) patients with a normal Kinaesthetic and Visual Imagery Questionnaire score; (5) patients who were 42–75 years of age; (6) patients who provided informed consent and were willing to participate in the study.

Exclusion criteria were: (1) patients with cognitive impairment Mini-Mental State Examination score of <24 in patients with a junior high school education or < 17 if illiterate; (2) patients with severe upper limb spasticity; (3) patients with severe bone joint malformation or myopathy; (4) patients with severe diseases of the heart, lung, liver, or kidney.

Patients eligible for inclusion in the study were divided into experimental and control groups based on a random number table. Patients failing to be treated for three consecutive times and those with an aggravated condition were excluded; thus, 61 patients in total were included in the statistical analyses (31 patients from the experimental group and 30 patients from the control group).

2.2. Research method

The Kinaesthetic and Visual Imagery Questionnaire was administered to all patients before and after treatment to determine and assess the specific operation method, procedure, time and intensity of the extremity rehabilitation. The evaluations were carried out by the same specialized nurse and rehabilitation therapist, who had undergone specific professional training, were unaware of the patient grouping status and did not participate in the treatment. Patients in both groups received conventional drug treatment, traditional physical therapy and occupational therapy for 2–5 h, six times/wk for a total of eight weeks. The patients in the experimental group additionally received action observation therapy for 30 min, six times/wk for eight weeks.

2.2.1. Action observation therapy

For limb movement training, patients were asked to sit at a distance of 2 m from a colour television set and place their affected arm on the table. They were required to first watch a video showing a specific action of the upper limb and then perform the same exercise after watching (Fig. 1). A total of 30 action videos were used, which depicted the same model performing the following: the bending and extension, abduction and adduction, and pronation and supination of the shoulder joint, shrug and adduction of the scapula, bending and extension of the elbow joint, bending and extension, ulnar deviation and radial deviation of the wrist joint, warping of a thimble, empty-handed grabbing, catch and release of large and small balls, cubes and cylinders, holding and release of a coin and a key, handling of an IC card, pen, chopsticks and computer mouse, screwing of a jar lid and narrow-mouthed bottle cap, typewriting, dialling on a mobile phone, grasping and release of a spoon, feeding training, and putting on clothes (including use of a zipper and button).

Each video was approximately 50 s in duration and depicted an action as seen from straight on (20 s), right above (15 s) and right inside (15 s); the complete action was recorded 2–3 times at each angle. Each action video was numbered according to the difficulty level of the action (1 = easiest, and 30 = most difficult). Videos with similar difficulty levels were
grouped into five groups of six videos each; Group 1 videos comprised the easiest actions and Group 5 videos comprised the most difficult. Patients were initially shown videos from Group 1 and instructed to try their best to simulate the action with their affected limbs. Once at least four of the actions could be performed, they moved on to the next group (higher difficulty) of videos.

2.3. Evaluation indices

2.3.1. FMA of the upper limb
The motion content of this scale includes the cooperative motions of reflection, shoulder, elbow, wrist and fingers, separation movement and 33 other items; the total integral score is 66 [6]. This scale has good reliability and validity, and is highly recommended for the evaluation of motor function after stroke [6].

2.3.2. Barthel index (BI)
The BI was used for evaluating the activities of daily living in the patients with stroke. This scale has good reliability for the evaluation of recovery of function in stroke patients [7].

2.3.3. Modified Ashworth scale (MAS)
This scale is used for evaluating the muscular tension of the upper limb elbow flexor and forearm pronator muscles. The grading standard of MAS includes six grades: 0, 1, 1°, 2, 3 and 4, which are recorded as 0 score, 1 score, 2 scores, 3 scores, 4 scores and 5 scores, respectively [8].

2.4. Statistical analysis

Data were analysed using SPSS 17.0 software (SPSS Inc., Chicago, IL, USA), and are expressed as means ± SD. The Kolmogorov–Smirnov test was used to determine if the data were normally distributed, in which case Student's t tests were used for intragroup comparisons; paired t tests were used for comparing scale scores and detection value differences after treatment. Abnormally distributed and ranked data were analysed with Wilcoxon signed ranks tests for intragroup comparisons, and the Mann–Whitney U test was used for comparing scale scores between groups and changes in value after treatment. A p value < 0.05 was considered statistically significant.

3. Results

There were no statistically significant differences between the experimental and control groups with respect to sex, age, disease course or hemiplegia location (Table 1). There were no significant differences in the evaluation indexes between the groups before treatment. However, FMA, BI and MAS scores were significantly improved in both groups after the 8-wk treatment compared to before treatment (all p < 0.05) (Table 2). Furthermore, FMA, BI and MAS scores were significantly better after treatment in the experimental group compared to the controls (all p < 0.05).

4. Discussion

Mirror neurons are a unique set of neurons that represent an “observation–execution matching mechanism”, which can unify the sensing and execution of an action. The goal of action observation therapy is to utilize this mechanism for the rehabilitation of upper extremity function in stroke patients.
via activation of the corresponding neural circuits [9]. Sinail et al. [10] showed that this mechanism plays a key role in the understanding and imitation of an action, motor imagery and learning and other important neurophysiological processes, with particular importance for upper limb movement function and daily activities in stroke patients. Wang et al. [11] used functional magnetic resonance imaging of stroke patients to show that those subjected to action observation therapy had a high signal in the affected primary and supplementary motor areas. Franceschini et al. [12] similarly used action observation therapy and showed that, compared to control patients who watched videos without people or animals, those who watched videos of daily activities prior to the conventional rehabilitation therapy exhibited greater improvement in muscle spasticity, motor function and daily activities after four weeks of treatment. The results of the current study support these findings and show that patients who undergo action observation therapy along with traditional rehabilitation have superior recovery after eight weeks as assessed by FMA, BI and MAS scores, which are reliable and valid assessments [13].

Additional studies indicate that activation of the mirror neuron system, such as with action observation therapy, represents a new strategy for recovery of motor function after stroke [14,15]. 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 are enhanced. Thus, this method may help patients to continue with long-term training schedules, which can curtail the formation of disuse syndrome and accelerate the recovery of upper limb movement, effectively improving the treatment efficiency [16]. As a result, application of this rehabilitation strategy may help to improve the prognosis and quality of life of patients with stroke.

There are limitations of this study that should be noted. Firstly, the mechanism by which action observation therapy enhances function recovery is not evaluated in this study. Thus, other factors related to the observation and re-enactment of actions may have contributed. Secondly, the number of patients included in this study was relatively limited. Therefore, additional studies involving larger patient cohorts from a wider geographic area are required to confirm these results.

5. Conclusion

The results of the current study demonstrate that supplementation of conventional rehabilitation with action observation therapy significantly improves the muscle spasticity, upper limb motor function and activities of daily living in hemiplegic patients with stroke. This combination therapy is worthy of clinical promotion and application.

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