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Original Article

Effect of Arm Ability Training on Functional Mobility and Dexterity in Hemiparetic Subjects

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Abstract

Objective Hemiparesis occurs when a stroke causes paresis on the body, contralateral to the lesioned brain. In poststroke patients, upper limb impairments induce functional restrictions. Arm ability training is a unilateral treatment for mild arm paresis. We evaluated the effectiveness of arm ability training on functional mobility and dexterity in hemiparetic subjects

Materials and Methods Forty-two hemiparetic subjects were selected by convenient sampling technique. The subjects were given 40 minutes of arm ability training and 20 minutes of conventional physiotherapy daily, five sessions a week extending for 4 weeks. Functional mobility was assessed through wolf motor function test (WMFT) and dexterity by box and block test (BBT).

Results The pre- and post-test scores were evaluated by paired *t*-test using SPSS software after 4 weeks of training period subjects showed much improvement for the BBT (mean $\pm$ standard deviation [SD]: 20.31 ± 4.075 vs. 23.79 ± 4.291), functional ability of WMFT (mean $\pm$ SD: 45.38 ± 3.615 vs. 54.07 ± 3.790), time of WMFT (mean $\pm$ SD: 479.29 ± 117.79 vs. 434.4 ± 116.455), the strength of WMFT was (mean $\pm$ SD: 2.95 ± 0.731 vs. 3.9 ± 0.759), and grip strength of WMFT (mean $\pm$ SD: 2.9 ± 1.559 vs. 4.21 ± 1.539), all variables indicating statistical significance ($p < 0.05$).

Conclusion Arm ability training proved effective in improving functional mobility and dexterity in hemiparetic subjects.

Keywords
- hemiparesis
- hand functions
- arm ability training
- wolf motor function and box and block

Introduction

Stroke is a "rapidly acquired clinical symptom of focal (or global) impairment of brain function lasting longer than 24 hours or leading to death, with no evident cause other than vascular origin" (World Health Organization [WHO]).[1] Throughout the world, stroke is a major disease that leads to mortality.[2] The prevalence of this condition in a rural area is 84,262/100,000, whereas it is 334,424/100,000 in an urban area.[3] Approximately 85% of strokes are ischemic, and 17.8% of those over 45 years of age.[4] Pathological subtypes include ischemic and hemorrhagic stroke.[5] Ischemic strokes can be classified according to the cause, which includes large artery atherosclerosis and cardiac emboli.[6] Atherosclerosis is a primary cause of ischemic stroke.[7] Acute hemorrhagic strokes make up 5 to 21% of all acute strokes.[8] Hypertension is a common cause of hemorrhagic strokes.[9] Hemorrhagic strokes can also be caused by vascular abnormalities.[10]

Stroke symptoms include one-sided weakness, disturbed vision, changed speech, ataxia, and associated symptoms. This might vary according to the origin of the stroke.[11] Hemiparesis occurs when a stroke causes paresis on the body, contralateral to the lesioned brain.[12] Mild paretic patients will move the limb normally or almost normally;

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however, hemiplegic subjects cannot move at all.[13] The hemiparetic patients were aimed to restore enough sensorimotor control to the limb.[14]

Stroke reduces mobility and can cause serious long-term disability.[15] After a stroke, over 90% of survivors experience some form of disability, which leads to functional limits and low quality of life. It directly influences health systems, which results in substantial costs, and is also regarded as a global public health problem.[16] Approximately 80% of hemiparetic patients have upper limb involvement.[17]

Current treatment includes a variety of methods to improve functional ability in hemiparetic subjects, like Bobath therapy,[18] constraint-induced movement therapy (CIMT),[19] injections,[20] electrical stimulation,[21] mental imagery,[22] and mirror box therapy.[23] Common conventional therapeutic interventions are frequent change in position and exercise therapy technique, which relies on the therapist and the requirements.[24] Hemiparetic and hemiplegic patients have quite different motor control impairments.[25] Arm ability training (AAT) is a systematic, standardized repeating training structure with eight training activities.[26]

Platz and Lotze[27] concluded that AAT encourages dexterity improvement after a stroke and is clinically effective. Although this study was done with the stroke population, it did not address functional mobility; thus, the need arises to identify the effect of AAT on functional mobility and dexterity in hemiparetic subjects.

Materials and Methodology

Subjects

Ethical clearance was taken from the institutional ethical committee of Krupanidhi College of Physiotherapy (Ref. No: EC-MPT/21/PHY/015). All 42 hemiparetic subjects were described in the study, and informed consent was taken from them. The study design was made as a single group pre and post-test experimental study with a convenient sampling technique. The study was conducted at the outpatient department of Krupanidhi College of Physiotherapy, Hospitals in and around Bangalore, and home care centers. The duration of the study was from June 2021 to June 2022. Subjects who had the ischemic type of stroke with anterior cerebral artery involvement and who were in the subacute phase of stroke (3 weeks to 6 months' post-stroke) were included. Hemiparetic patients with Mini Mental State Evaluation scores more than 24 and muscle strength ⅗ for shoulder abduction and elbow flexion, according to Medical Research Council, were included. The subject should be able to move their fingers, and a precision grip should be preserved.[27,28] The study includes both genders with an age limit of 45 to 70 years. Hemorrhagic stroke, deformities of the upper limb, epilepsy, fractures, sensory impairment, and visual & auditory deficits patients were excluded. Participants received 40 minutes of AAT and 20 minutes of conventional physical therapy. The treatment was given for five sessions in a week extending for 4 weeks. Measurements were taken before and after the treatment.

Procedure

Arm Ability Training[28]

The participants were given AAT along with conventional therapy. Patients were given instructions regarding AAT, and a demonstration was done. AAT includes eight different extremity tasks: (a) Aiming—To touch a given aim with maximum speed; (b) Tapping is the alternative movement between the first, second, and third digits. (c) Cancellation: To cancel the circles of various sizes given on paper. (d) Turning: Turning of coins placed on a table surface. (e) Maze tracking: To track the maze printed on paper with a pencil. (f) Bolt and nut: to screw the nuts and bolts. (g) Placing small objects: placing small wooden blocks on top of each other. (h) Placing large objects: objects with different weights and volumes were moved side to side.

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Subjects were instructed to do the activities such as folding towels, removing bottle caps, turning keys, turning cards upside down, holding a pencil and drawing a line, and putting coins in the money box to increase functional mobility. Slow sustained stretching and strengthening exercises were also given for the paretic upper extremity.[29]

Measurement Tools and Method

Wolf motor function test (WMFT)was taken to evaluate functional mobility.[30] The dexterity was measured using box and block test (BBT).[31]

Statistical Analysis

Descriptive statistics were performed to calculate the demographic variables and outcome variables. A paired *t*-test was used to know the significant difference among the variables pre and post-test BBT and WMFT. The data were analyzed using SPSS version 29.0. The level of desired significance was kept at 5%. The samples that are collected from the subjects are normally distributed with 95% value.

Results

The average age group of study subjects was 54.93 ± 7.819 years of 45 to 70 years. The average body mass index of the samples was 27.34 ± 2.424 kg/m^2 of 23.2 to 32.6 kg/m^2. The responses obtained were 28 (66.7%) and 14 (33.3%) from males and females respectively.

Paired t-test was used to analyze the pre- and post-treatment evaluation for BBT and WMFT. The results attained showed a significant improvement in all variables (►**Table 1**); BBT pre-test mean ± standard deviation (SD; 20.31 ± 4.075) and post-test mean ± SD (23.79 ± 4.291), which indicate dexterity improvement. Functional ability of WMFT pre-test mean ± SD (45.38 ± 3.615) and post-test mean ± SD (54.07 ± 3.790) shows a significant improvement in functional ability. Time (seconds) of WMFT pre-test mean ± SD (479.29 ± 117.79) and post-test mean ± SD (434.4 ± 116.455) shows an improvement in time. Strength (lbs.) of WMFT pre-test mean ± SD (2.95 ± 0.731) and

Table 1 Outcome measures—pre- and post-treatment evaluation

Tests	Pre-test mean	Post-test mean	Mean difference	SD	*t*-Value	*p*-Value	Significance
BBT	20.31	23.79	−3.476	1.273	−17.692	0.001	Highly significant
Functional ability of WMFT	45.38	54.07	−8.690	1.689	−33.344	0.001	Highly significant
Time (seconds) of WMFT	479.29	434.40	44.881	38.139	7.626	0.001	Highly significant
Strength (lbs.) of WMFT	2.95	3.90	−0.952	0.216	−28.636	0.001	Highly significant
Grip strength (kg) of WMFT	2.90	4.21	−1.310	0.643	−13.189	0.001	Highly significant

Abbreviations: BBT, box and block test; SD, standard deviation; WMFT, wolf motor function test.

post-test mean ± SD (3.9 ± 0.759) shows an improvement in strength. Grip strength (kg) of WMFT pre-test mean ± SD (2.9 ± 1.559) and post-test mean ± SD (4.21 ± 1.539) shows an improvement in grip strength. There is a statistically significant difference for the variables BBT and WMFT (functional ability, time [seconds], strength [lbs.], and grip strength [kg]) and getting the *p*-value = 0.001 (<0.05) which indicates its highly significant.

Discussion

After a stroke, the paretic hand is a typical motor disability in which dexterity becomes impaired, which may restrict activities of daily living performance and social engagement and lower the quality of life for stroke patients.[32] The primary factor in determining how well the affected arm functions is the return of use to a paretic hand. Therefore, enhancing hand functions to encourage functional recovery is one of stroke rehabilitation's main objectives.[33] The AAT is a complicated motor training program specifically created for hemiparetic subjects.[34] The study objective was to know the effectiveness of AAT on functional mobility in hemiparetic patients. The efficacy of this study revealed improvement in upper limb functional mobility, time, grip strength, strength, and dexterity in hemiparetic patients.

In a study by Jose et al,[35] similar results were found showing good improvement in the upper limb functional skills in Parkinson's subjects. Similarly, Ladda et al[36] demonstrated an increase in the grip force in a study of 15 participants ($t = -3.02$, $p = 0.01$). Improvements were also observed in performance level over time in fine movements measured with Nine Hole Peg Test (NHPT; left: $p = 0.01$ and right: $p = 0.05$). There was a good improvement in hand performance over time (left: 34.1 ± 1.2 and right: 23.8 ± 1.0). Similar findings were also noticed in a study by Horn et al,[37] where all 12 patients had shown improvement in performing the task. The duration of AAT tasks decreased by 27.7% ($t = 17.61$, $p = 0.001$). The NHPT duration declined by 25.2% ($t = 3.28$, $p = 0.007$). BBT (number of block) increased by 20.9% ($t = 8.74$, $p = 0.001$). This study is also supportive from the study results by Lotze et al,[38] where the arm's ability showed (27.79 ± 4.70) improvement within 2 weeks, which is a significant improvement in time ($t = 20.07$; $p = 0.001$). While the unaffected side's performance on the **T**est **E**valuation es **M**embres Suprieurs de **P**ersonnes **A**gres (TEMPA) tasks did not change with time, the impacted side did ($p = 0.001$). AAT and TEMPA improvement in the paretic arm was positively correlated ($r = 0.59$; $p = 0.028$). Platz et al[28] found that the AAT decreased the focal impairment in hemiplegic and traumatic brain injury subjects with upper extremity paralysis. The patients showed the improvement by reducing the time required to complete the TEMPA tasks. The effects were unaffected significantly by knowing the outcome. At the 1-year follow-up, a functional advantage was seen as patients' TEMPA task summary time scores improved by 51.3 seconds ($p = 0.0012$) over pretest scores.

AAT facilitates motor learning in terms of maintenance and generalization of training effects.[34] Its design encourages intrinsic motivation, places premium neuroplasticity, and significantly improves a range of sensorimotor hand and arm abilities with lasting consequences, and also the functional reorganization of the brain with activation of premotor cortex among hemiparetic subjects underlies training-induced recovery of arm functions and similarly training-induced plasticity.[26] Additionally, two fundamental treatment philosophies shape conventional physiotherapeutic methods; the first is that the adult central nervous system may adapt or reorganize itself in some ways to restore impaired cognitive and motor functions, and the second is that, at any point following the onset of a stroke, ongoing improvement requires progressive skillful motor practice. Therefore, the repetition of certain tasks and exercises, local facilitation approaches, and motor relearning procedures can all be credited with the results.[39] With the above-discussed mechanism, it is proved that AAT and conventional physical therapy can result in greater functional mobility and dexterity in hemi-paretic patients.

Limitation and Suggestions

The study was conducted only on a single group. It can be done with CIMT for comparison. The study findings cannot be generalized to all stroke patients. A study can be done with chronic stroke patients and large sample size to determine the effectiveness. The study lacks follow-up; the long-term effect of the intervention can be checked.

Conclusion

Hemiparesis can result in functional restriction due to upper extremity weakness. It was proposed that AAT is a useful intervention for enhancing hemiparetic individuals' upper extremity function. The results demonstrate that adding AAT to the rehabilitation routine significantly improved stroke patients' upper extremity function, strength, grip strength, and dexterity. The proposed AAT can be used as adjunct training to be included with the conventional program to improve the patient's functional ability in hemiparesis.

Conflict of Interest
None declared.

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