PILOT STUDY

# Effects of bilateral arm training on upper extremity function in right and left hemispheric stroke

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## Abstract

**Objective:** This experimental study on 24 stroke patients aimed at evaluating and comparing the effects of bilateral arm training on upper extremity (UE) motor function between right and left hemispheric chronic stroke patients.

**Methods:** Both groups received the same intervention involving 5 functional tasks for 1 hour, 3 days per week, for a total of 6 weeks. Fugl-Meyer Assessment-Upper Extremity and Wolf-Motor Function Test were applied as outcome measures at baseline and after 6 weeks of training to assess the recovery of function in the affected area.

**Results:** Intra-group analysis showed no significant improvement in the wrist and hand function in the left hemispheric stroke (LHS) ($p>0.05$), while right hemispheric stroke (RHS) patients did not improve significantly in the coordination/speed domain ($p>0.05$). Inter-group analysis showed no significant difference between right and left hemispheric stroke patients ($p>0.05$).

**Conclusion:** Bilateral arm training showed beneficial effects in improving UE function in both RHS and LHS patients. Distal UE function in LHS and coordination and speed of movement in RHS patients did not show any significant improvement.

**Keywords:** Stroke, Upper extremity, Recovery of function, Bilateral arm training. (JPMA 71: 302; 2021)

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## Introduction

Stroke falls under the category of one of the leading causes of persistent, long-term disability.[1] Stroke survivors experience extensive sensorimotor deficits in affected upper and lower extremities, the most common being the upper extremity (UE), affecting approximately 80% of the acute stroke patients and 40% of the chronic stroke survivors. Common manifestations include compromised motor control, muscle paresis, alterations in muscle tone, stiffness, spasticity and contractures which consequently lead to impaired ability to perform activities of daily living (ADLs) and, therefore, increased dependence.[2] Around 89% of the stroke patients in Pakistan are mostly dependent on performing ADLs.[3] Several rehabilitation strategies have been devised for UE recovery of function in chronic stroke, including constraint-induced movement therapy (CIMT) and bilateral arm training (BAT) that are used most widely.[4] CIMT has been demonstrated to be an effective strategy to enhance UE function significantly after stroke, but there are a number of limitations associated with it, like safety concerns, decreased functionality due to restrained use of the non-affected UE, prerequisites like voluntary wrist extension and some degree of thumb abduction before being able to participate in the therapy.[5,6] On the contrary, chronic stroke patients do not need to fulfil such criteria for BAT which promotes the use of the paretic limb simultaneously with the non-paretic limb. Many of our daily chores are bimanual and utilise concurrent use of both arms. BAT is believed to induce neural coupling effects in the brain and facilitate regaining function along with improved bimanual coordination of the UEs.[7] According to Parker et al., around 90% of the nerve fibres decussate and control the movements of the contralateral body while the remainder control movements on the same side. Therefore, movements involving non-paretic limb can stimulate the movement of the paretic limb.[8] Furthermore, performing bimanual tasks activates primary and supplementary motor cortices which can potentially enhance the motor firing and voluntary muscle work in the paretic extremity.[9] BAT has sufficient evidence regarding its effectiveness, with a systematic review and meta-analysis having demonstrated that BAT is an effective strategy in chronic upper-limb stroke recovery.[9] However, there is still limited evidence on its effects with regard to the side of the hemispheric lesion. This is of particular importance because evidence demonstrates contrasting motor deficits in right hemispheric stroke (RHS) and left hemispheric stroke (LHS). A study showed that LHS subjects produced bilateral motor deficits, whereas RHS patients exhibited

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substantial motor deficits in the involved limb only.[10] The current study was planned to compare the effects of BAT in RHS and LHS patients.

## Methods and Results

The experimental study (www.clinicaltrials.gov NCT03762980)[11] was conducted at a private clinic in Rawalpindi from April 2016 to September 2016. After approval from the ethics review board of Shifa International Hospital, Islamabad, Pakistan, the sample size was determined. To our knowledge, there have not been any large-scale studies comparing BAT between RHS and LHS patients, and, therefore, we adopted the recommendation suggesting a minimum sample size of 12 subjects per treatment arm for the current pilot study.[12] The sample was raised using convenience sampling technique, and informed written consent was taken from all the subjects who volunteered to participate. Of the 32 patients initially assessed, 24(75%) were enrolled.

Those included were diagnosed cases of left and right-sided ischaemic lesions aged 30-70 years with at least 3 months of post-stroke duration, and who had some ability to move the paretic arm in antigravity direction. Those excluded were patients with haemorrhagic stroke, significant aphasia, visual or cognitive deficits or those on medications that could potentially interfere with their cognitive functions or patients with any other neurological condition.

The sample was divided into RHS Group A with 12(50%) subjects and LHS Group B with as many patients. Each group received 3 one-hour sessions of BAT per week for 6 weeks. BAT included the performance of five functional tasks, including stacking cones, positioning the cup upright, throwing a tennis ball into a basket, carrying a wooden block, and buttoning and unbuttoning of a shirt with counting. Each task was performed for 10 minutes followed by a rest period of 2 minutes. Motor function of UE was assessed using Fugl-Meyer Assessment for Upper Extremity (FMA-UE)[13] and Wolf Motor Function Test (WMFT)14. FMA-UE is used to assess the motor function of the UE with a total score of 66 and consists of 4 domains: UE, wrist, hand, and coordination/speed. The modified version of WMFT was utilised which consists of 17 items. It measures the motor function of UE through the performance of different tasks. The first 6 items of WMFT analyse timed functional tasks, items from 7-14 assess the strength, and the rest evaluate the quality of movement. The items are scored on a 6-point functional ability scale; 0 being the lowest and 6 being the highest with normal movement.

Both groups were assessed at baseline and after 6 weeks of BAT therapy. Data was analysed using SPSS 19. For descriptive analysis, quantitative variables were computed using mean and standard deviation (SD) and categorical variables were presented using frequencies and percentages. For intra- and inter-group analyses, non-parametric Wilcoxon signed rank test and Man-Whitney U

**Table:** Intra-group analysis of Right and Left hemispheric stroke on FMA-UE and WMFT.

| Within Group Analysis | Baseline (Mean±S.D) | Post intervention (Mean±S.D) | Mean Difference | p-value |
|---|---|---|---|---|
| **RHS** | | | | |
| FMA -UE | 19.30±10.39 | 29.00±7.80 | 9.70 | 0.02* |
| FMA-Wrist | 4.30±3.80 | 6.80±4.02 | 2.50 | 0.02* |
| FMA-Hand | 5.20±4.23 | 9.30±4.88 | 4.10 | 0.007** |
| FMA-Coordination/Speed | 2.10±1.85 | 4.30±2.16 | 2.20 | 0.08 |
| FMA-Total | 30.90±17.28 | 49.40±15.64 | 9.50 | 0.01* |
| WMFT-Total | 1.80±1.14 | 3.42±1.28 | 1.62 | 0.005** |
| **LHS** | | | | |
| FMA-UE | 11.67±13.99 | 28.44±8.54 | 16.77 | 0.008** |
| FMA-Wrist | 3.00±2.95 | 6.77±3.38 | 3.77 | 0.05 |
| FMA-Hand | 4.88±4.72 | 9.44±4.82 | 4.56 | 0.06 |
| FMA-Coordination/Speed | 2.11±2.26 | 3.67±1.87 | 1.56 | 0.02* |
| FMA-total | 21.67±22.90 | 48.33±16.93 | 26.66 | 0.01* |
| WMFT-total | 1.25±1.26 | 2.65±1.23 | 1.40 | 0.008** |

FMA-UE: Fugl MeyerAssessment-Upper Extremity
WMFT: Wolf Motor Function Test
RHS: Right hemispheric stroke
LHS: Left hemispheric stroke
S.D: Standard deviation
*p-value less than 0.05
** p-value less than 0.01.

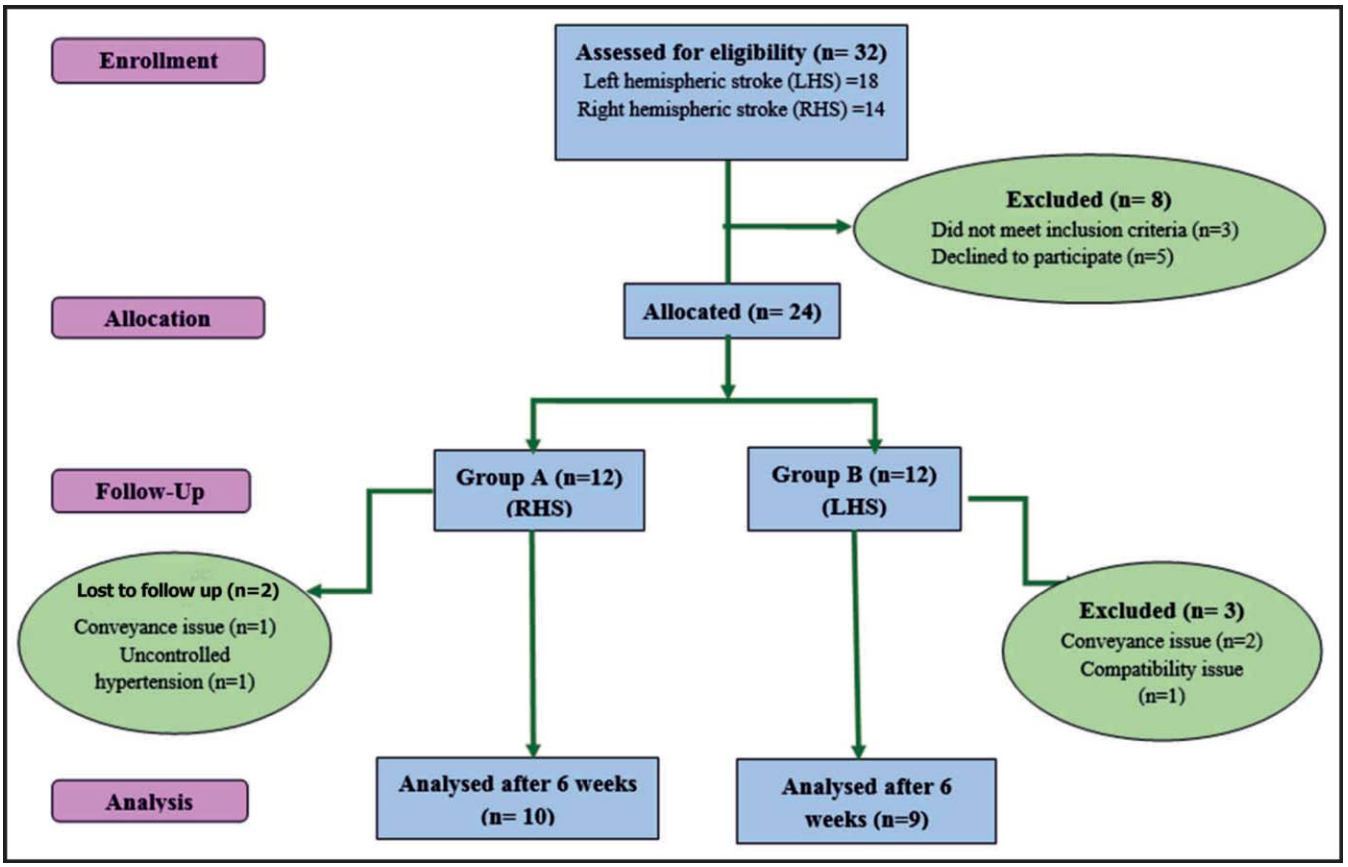


**Figure:** Study flow diagram.

test were used respectively as the sample size was <30.

Of the 24 participants enrolled, 19(79%) completed the study; 10(52.6%) in Group A with 6(60%) males and 4(40%) females, and 9(47.4%) in Group B with 4(44.4%) males and 5(55.6%) females. The mean age of Group A was 50.70±10.04 years and in Group B it was 56.88±10.84 years. The overall age ranged from 32-70 years. All participants in both the groups were affected with middle cerebral artery (MCA) stroke and were right hand dominant. On FMA-UE, Group A showed significant differences in the UE, wrist, hand and overall scores ($p<0.05$) and showed non-significant changes in coordination and speed ($p\geq0.05$). In group B, UE, coordination and speed, and overall scores showed significant differences ($p<0.05$), whereas scores of wrist and hand did not show significant improvement ($p \geq0.05$). WMFT scores demonstrated significant statistical intra-group differences, but inter-group differences were not significant ($p\geq0.05$). Inter-group comparison showed no significant differences on all measures of FMA-UE and WMFT (Table).

## Conclusion

BAT using functional tasks showed beneficial effects in improving UE function in both RHS and LHS patients. Distal UE function in LHS patients and coordination and speed of movement in RHs patients did not show remarkable improvement.

**Disclaimer:** The text is based on an MS thesis done at Riphah International University, Islamabad.

**Conflict of Interest:** None.

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