ORIGINAL ARTICLE

Responses of the Less Affected Arm to Bilateral Upper Limb Task Training in Early Rehabilitation After Stroke: A Randomized Controlled Trial

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ABSTRACT. Morris JH, Van Wijck F. Responses of the less affected arm to bilateral upper limb task training in early rehabilitation after stroke: a randomized controlled trial. Arch Phys Med Rehabil 2012;93:1129-37.

Objectives: To investigate effects of bilateral training (BT) on ipsilesional arm dexterity and activity limitation; to explore clinical and demographic factors that influence training effects; and to explore relationships between contralesional and ipsilesional recovery.

Design: Single-blind randomized controlled trial with outcome assessment at baseline, postintervention (6wk), and follow-up (18wk).

Setting: Inpatient acute and rehabilitation hospitals.

Participants: Participants were randomized to a BT group in which training involved the ipsilesional and contralesional arms (n=56) or control training involving the contralesional arm only (n=50).

Interventions: Supervised BT or control training for 20 minutes on weekdays over a 6-week period using a standardized program.

Main Outcome Measures: Upper limb activity limitation: Action Research Arm Test; and dexterity: Nine-Hole Peg Test (9HPT).

Results: Lower baseline scores were found for the ipsilesional arm on both measures compared with published normative values. The BT group demonstrated significantly greater change in dexterity (P=.03) during the intervention phase at 0 to 6 weeks (.06±.07pegs/s) compared with the control group (.02±.02pegs/s). The effect was lost for overall recovery at 0 to 18 weeks (P=.93). Younger participants (age≤68y) performed the 9HPT faster at baseline than older participants (P=.04) and demonstrated greater overall recovery with BT than older participants (P=.04). There was no significant correlation between ipsilesional and contralesional recovery.

Conclusions: The study suggests that BT may lead to clinically small improvements in ipsilesional performance of fine, rapid dexterity tasks. Younger participants responded better to BT. There was no relationship between contralesional and ipsilesional recovery, suggesting that different causes and recovery mechanisms may exist.

Key Words: Rehabilitation; Stroke; Upper extremity.

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STROKE IS THE MAIN CAUSE of complex adult disability in the western world,[1,2] leading to contralesional hemiparesis that adversely affects independence in daily activities.[3] However, as well as contralesional hemiparesis, deficits in ipsilesional upper limb (UL) motor performance,[4-8] fine dexterity,[9-11] finger tapping,[12,13] and functional performance[14] have been demonstrated. Ipsilesional impairments—although subtle—may adversely affect activities of daily living,[6,7,15] because people with contralesional hemiplegia often use the ipsilesional UL for functional tasks. Understanding ipsilesional dysfunction and how it can be improved is therefore an important issue in stroke rehabilitation.

Several bilateral neural mechanisms may explain ipsilesional UL dysfunction. Cortical motor area damage may directly affect the 15% to 20% of uncrossed corticospinal fibers that provide some ipsilateral control of unilateral movements. This may cause alterations in ipsilesional UL performance.[16-18] Secondly, bilaterally organized neural network functioning, which becomes increasingly active as task complexity increases, may be affected after stroke.[19,20] Loss of network integrity may affect motor control, manifesting itself in ipsilesional performance deficits.[21-23] Finally, after stroke, the undamaged primary motor cortex receives lowered interhemispheric inhibition from the lesioned hemisphere,[24-27] which may interfere with normative motor control, causing ipsilesional dysfunction.[28] Therapeutic approaches with potential to normalize bilaterally organized neural mechanisms[26,29] may thus lead to improved clinical ipsilesional UL performance.

Bilateral training (BT) was developed to address contralesional UL dysfunction after stroke. During BT, identical tasks are practiced with contralesional and ipsilesional arms simultaneously—but independently. Simultaneous task practice with both ULs may modulate hemispheric excitability, restore more normative interhemispheric inhibition, and improve contralesional UL motor functioning.[26,30] Although evidence for BT in contralesional hemiplegia remains inconclusive,[31] BT has been shown to improve ipsilesional finger tapping coordination.[32] The impact of BT on more functional ipsilesional outcomes is, however, unknown. It also remains unclear whether clinical and demographic factors influence ipsilesional func-

List of Abbreviations

ARAT	Action Research Arm Test
BT	bilateral training
9HPT	Nine-Hole Peg Test
UL	upper limb

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tion, recovery, and training responses. Furthermore, relationships between ipsilesional and contralesional recovery have not been extensively examined.

The aims of this study were to: (1) confirm that ipsilesional UL dysfunction soon after stroke is detectable on standardized clinical measures compared with published norms; (2) test the hypothesis that there would be a significant difference in ipsilesional UL recovery between groups receiving BT versus a control intervention; (3) compare ipsilesional performance of participants with different age, sex, hand dominance, stroke classification, and side of hemispheric lesion and—where baseline differences did exist—to investigate whether training responses also differed; and (4) to explore relationships between ipsilesional and contralesional UL recovery.

METHODS

Design

This study was part of a randomized controlled trial investigating effects of BT compared with unilateral task training for the hemiparetic arm. Participants assigned to BT simultaneously practiced identical tasks with both ULs. Participants assigned to unilateral training practiced tasks with the hemiparetic arm only. This group formed the control intervention group for the present ipsilesional study. Assessment occurred at baseline, postintervention at 6 weeks, and follow-up at 18 weeks. Preliminary findings on the effects of BT on the hemiparetic arm have been published previously.[33]

Participants

Participants were recruited from a patient cohort sequentially admitted to an acute stroke unit with rehabilitation facilities. The local medical research ethics committee provided ethical approval. Participants were identified from medical records and screened for an inclusion 2 to 4 weeks after stroke onset by the lead researcher (J.H.M.). Inclusion criteria were: acute unilateral stroke confirmed on computed tomography scan; contralesional score of less than 6 on UL sections of the Motor Assessment Scale[34]; ability to participate in 30-minute physiotherapy sessions; and the ability to sit unsupported for 1 minute. Exclusion criteria were: severe neglect, aphasia, or cognitive impairment; previous stroke-related disability; premorbid contralesional arm impairment; hemiplegic shoulder pain; and the inability to provide informed consent.

Measures of Ipsilesional UL Activity Limitation

Ipsilesional training effects were evaluated using the following 2 measures.

Nine-Hole Peg Test. The Nine-Hole Peg Test (9HPT) assessed fine manual dexterity. The published norm for the 9HPT completion in an elderly population with a mean age ± SD of 72±9.9 years is .68±.14 pegs/s.[35] Data for the present study were presented as pegs per second and timing was conducted using a stopwatch.

Action Research Arm Test. The Action Research Arm Test (ARAT) is a validated and reliable measure of UL activity limitation,[36] comprising 19 items organized into 4 subsections: grip, grasp, pinch, and gross movement. Scores of 0 indicate that no part of an item was performed; 3 indicates normative item performance. The maximum summed score is 57, indicating normative performance. Published guidelines were used.[37]

To describe sample characteristics more fully, the Modified Barthel Index was assessed at baseline. The Modified Barthel Index assesses independence in activities of daily living.[38] Scores range from 0 to 100; higher scores indicate greater independence.

Power calculations for the main study determined a sample size of 53 patients per group based on change in contralesional ARAT scores.[33]

Randomization and Blinding

Randomization using a concealed, web-based computerized randomization system was conducted 2 to 4 weeks after stroke onset after written informed consent and baseline assessment. An occupational therapist blinded to treatment allocation collected data. The therapist left after recruitment of 50 participants and was replaced by a physiotherapist. Both were trained in use of the measures. Additionally, inter- and intrarater reliability was assessed by each rater independently scoring videotaped ARAT performances. Single-measure intraclass correlation coefficients for raters were greater than .95 ($P<.001$), which could be classified as high.

Intervention

Bilateral group (n=56). The BT group practiced identical tasks simultaneously with both arms. Training lasted 20 minutes per day, 5 weekdays per week over 6 weeks, in addition to usual therapy. Equipment and task protocols were standardized. Participants practiced 4 tasks based on work by Mudie and Matyas[39,40]: (1) move a doweling peg 2cm diameter × 4cm height from the tabletop and attach to the underside of a shelf placed at eye level; (2) move a 7-cm^3 block from the table onto a shelf at shoulder height; (3) grasp an empty glass, take to the mouth, and return to starting position; and (4) point to targets raised 30cm from the table and positioned at midline, 40cm to the right, and left of midline. Tasks were organized into a progressive training program based on contralesional limb performance. Details of task progression, feedback, and practice scheduling are described elsewhere.[33] Participants performed a maximum of 30 trials of each task; a total of 120 trials per session. Outside the training session, participants used their ipsilesional UL as they wished, no instructions were issued and no control was placed on this activity.

Control group (n=50). The control group practiced identical tasks to the BT group but with the contralesional, hemiparetic UL only. They received no ipsilesional UL training and no instructions relating to ipsilesional UL activity.

Procedures

Potential participants were screened and provided with study information. After obtaining informed consent and baseline assessment, participants were randomized to BT or control groups. The lead investigator (J.H.M.) entered participant identification numbers into the randomization program with the following stratification factors: side of hemiplegia, stroke classification according to the Oxfordshire Stroke Classification,[41] and baseline contralesional UL activity measured by the ARAT. Therapists were then informed of group allocation.

Measures were conducted at baseline (2–4 weeks after stroke onset), immediately after training (at 6 weeks after baseline), and at 18 weeks (at 12 weeks after intervention completion). To maintain blinding, participants were instructed not to indicate group allocation to assessors.

One senior stroke rehabilitation physiotherapist delivered the intervention in the acute hospital and a second delivered it in rehabilitation facilities to which participants were transferred across Tayside, both following the same intervention manual. Intervention occurred away from normal therapy areas. Participants discharged home during the intervention period received the intervention there 2 days per week, to reflect usual service delivery pattern.

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