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ORIGINAL ARTICLE

Effects of Integrated Motor Imagery Practice on Gait of Individuals With Chronic Stroke: A Half-Crossover Randomized Study

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Abstract

Objectives: To test the effects of a new motor imagery practice approach, in which motor and motivational contents were integrated in order to improve gait in subjects with chronic poststroke hemiparesis.

Design: A half-crossover study composed of 2 phases. In phase 1, subjects were randomly assigned to receive either the experimental or the control treatment. In phase 2, the subjects who had initially received the control treatment "crossed over" to receive the experimental intervention.

Setting: The experimental and the control intervention were delivered in the subjects' homes; assessments were performed in a hospital laboratory.

Participants: Community-dwelling individuals (N=23) with chronic poststroke hemiparesis whose gait was impaired.

Interventions: The experimental intervention, called integrated motor imagery practice, consisted of imagery scripts aimed at improving home and community walking as well as fall-related self-efficacy. The control treatment consisted of executed exercises to improve the function of the involved upper extremity.

Main Outcome Measures: In-home walking, indoor and outdoor community ambulation, and fall-related self-efficacy. These were assessed before and after the intervention as well as at a 2-week follow-up.

Results: In-home walking was significantly improved after application of the experimental intervention ($P\leq.003$), but not after the control treatment ($P\leq.68$). Community ambulation did not improve. Fall-related self-efficacy was slightly improved by the integrated motor imagery intervention; however, the findings were not unequivocal.

Conclusions: Home delivery of integrated motor imagery practice was feasible and exerted a positive effect on walking in the home. However, it was ineffective for improving gait in public domains. We speculate that the addition of physical practice to imagery practice may be essential for achieving that end.

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Walking recovery is a primary goal in poststroke rehabilitation. Six months after a stroke, 30% of individuals with residual hemiparesis still require assistance to walk.[1] They may have as much as a 50% decrease in gait speed as compared with age-matched healthy adults[2] and may experience a decrease in community ambulation[3,4] compared with sedentary adults.[5,6] In addition, they have a high rate of falling[7,8] and fear of falling,[9,10] as well as a low fall-related self-efficacy, all of which contribute to restricted community mobility.

Limited resources and access to outpatient services in part hamper delivering interventions in the community. The implementation of a safe and inexpensive intervention that remediates gait limitations as well as self-confidence and motivation would address these barriers.[1] Motor imagery (the imagining of actions without their execution)[11] practice of locomotor activities is one

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such program that has demonstrated the potential to improve the gait of persons poststroke.[12,13]

We propose that the motor imagery practice of gait may be further enhanced by the addition of motivational imagery, which is used to imagine arousal and affect and has been associated with improvements in self-efficacy.[14] Motor imagery practice invokes activity in a widespread neural network that includes brain areas involved in attention and arousal.[15] Therefore, it is conceivable that imagery training that includes motivational elements in addition to motor elements also would further enhance relevant brain activity. Notably, components of motivational imagery are frequently applied in sports and dance and reported to facilitate performance and self-confidence.[16-19] However, with the exception of a case report[14] published by our group, their systematic application has not been documented for individuals poststroke.

Thus, the main goal of this preliminary feasibility study was to implement and test the outcomes of an integrated motor imagery practice intervention that combined motor and motivational imagery to remediate the residual walking deficits and self-efficacy of community-dwelling individuals poststroke. We hypothesized that home-based application of integrated motor imagery would improve gait speed, community ambulation, and fall-related self-efficacy.

Methods

Participants

Participants were recruited from the registry of Flieman Geriatric Rehabilitation Hospital in Haifa, Israel. Potential participants were screened, and after a presentation of the project, consent was obtained in their homes by a physical therapist.

Participants were included if they were community-dwelling individuals, 60 to 80 years of age, who had sustained a unilateral stroke at least 6 months and no more than 2 years before recruitment. Only subjects reporting limited indoor and outdoor ambulation because of the stroke and whose Mini-Mental State Examination score,[20] tested at the home visit, was 24 points or higher and who were not receiving physical therapy were included. Exclusion criteria were wheelchair use, severe ailments including psychiatric disorders and major depression, and communication deficits.

The number of participants was based on a power analysis with the following determinants: (1) a minimal clinically meaningful improvement (±SD) of .15±.14m/s in indoor gait speed after the experimental intervention, as based on prior studies,[12,21] with no improvement (0±.14m/s) after the control treatment; (2) a power of 80%; and (3) an alpha error of 5% or less. According to the analysis, at least 11 individuals should receive the experimental integrated motor imagery and 11 the control treatment.

List of abbreviations:

ANCOVA	**analysis of covariance**
ANOVA	**analysis of variance**
C	**control**
CI	**confidence interval**
ES	**effect size**
FESS	**Falls-Efficacy Scale, Swedish version**
FU	**follow-up**
I	**integrated imagery intervention**
RM	**repeated measures**
SAM	**step activity monitor**

Participants were randomly assigned to receive either the experimental or the control treatment; randomization was based on a minimization scheme, which ensured balance in gait speed (with speed of .42m/s dividing subjects into "low-" and "high-level" walkers)[22,23] as well as in age and sex.

Study design

The study design was a half crossover with two 4-week phases. In phase 1, 13 participants were assigned to the experimental integrated imagery (I) practice and 12 to the control (C) treatment. In phase 2, the subjects who had initially received the control treatment "crossed over" to receive the integrated imagery practice. The choice of the design was prompted by the ability to compare between treatments (experimental vs control) as well as within subjects receiving the experimental intervention (pre- vs post-).[24] A similar design was used for studying the effect of motor imagery on complex regional pain.[25]

The integrated imagery intervention applied during phase 1 was called I_1, and the identical intervention applied during phase 2 was called I_2. For participants allocated to I_1, a postintervention assessment (post-I_1) was conducted immediately afterward, with follow-up (FU) testing 2 weeks later. A posttreatment assessment was also performed for subjects allocated to the control treatment (post-C), its purpose being to confirm that the control treatment had no carryover effect on the subjects' gait. The post-C assessment served as the pre-I_2 assessment for the crossed-over subjects who then received the integrated imagery intervention (I_2), with assessments conducted at post-I_2 and at the 2-week FU. A flowchart of the recruitment process and study design is presented in figure 1.

Assessments

Assessments were performed by 2 physical therapists (M.K., A.D.) blinded to group treatment assignment. All subjects underwent a baseline assessment, which included (1) an oral interview to determine the participants' mobility limitations and therapy goals and (2) tests of motor, sensory, and cognitive functions including imagery ability. Outcome variables were measured at pretest, posttest, and follow-up.

Outcome variables

The primary measure of home ambulation was the 10-m walk test.[26-28] Fall-related self-efficacy was measured with the Falls-Efficacy Scale, Swedish version (FESS),[29,30] which resembles the fall-related self-efficacy scale of Tinetti et al[31] with the addition of 3 questions tailored for poststroke subjects. Community ambulation was determined by data collected via the step activity monitor[a] (SAM),[5,6,27] which was donned by each participant during wake time in the 60 hours after each assessment. The SAM has frequently been used to gauge community ambulation after stroke, with the main outcome variable being the number of steps taken within a predefined period.[27,32,33] In addition, we used the measurement of "maximal activity," defined as the number of steps taken per minute during the most active hour of the day.

Procedures: interventions

Both the experimental and the control interventions were administered in the participant's home. They consisted of 15-minute sessions conducted 3 times a week for 4 weeks. Three physical