ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2015;96:388-94

ORIGINAL ARTICLE

Improving Motor Control in Walking: A Randomized Clinical Trial in Older Adults With Subclinical Walking Difficulty

Jennifer S. Brach, PhD, PT,[a] Kristin Lowry, PhD, PT,[b] Subashan Perera, PhD,[c] Victoria Hornyak, DPT, PT,[a] David Wert, PhD, PT,[a] Stephanie A. Studenski, MD, MPH,[d] Jessie M. VanSwearingen, PhD, PT[a]

From the [a]Department of Physical Therapy, University of Pittsburgh, Pittsburgh, PA; [b]Department of Physical Therapy, Des Moines University, Des Moines, IA; [c]Division of Geriatric Medicine, University of Pittsburgh, Pittsburgh, PA; and [d]Longitudinal Studies Section, National Institute on Aging, Baltimore, MD.

Abstract

Objective: To test the proposed mechanism of action of a task-specific motor learning intervention by examining its effect on measures of the motor control of gait.

Design: Single-blinded randomized clinical trial.

Setting: University research laboratory.

Participants: Adults (N=40) aged ≥65 years with gait speed >1.0m/s and impaired motor skill (figure-of-8 walk time >8s).

Interventions: The 2 interventions included a task-oriented motor learning and a standard exercise program; both interventions included strength training. Both lasted 12 weeks, with twice-weekly, 1-hour, physical therapist–supervised sessions.

Main Outcome Measures: Two measures of the motor control of gait, gait variability and smoothness of walking, were assessed pre- and postintervention by assessors masked to the treatment arm.

Results: Of 40 randomized subjects, 38 completed the trial (mean age ± SD, 77.1±6.0y). The motor learning group improved more than the standard group in double-support time variability (.13m/s vs .05m/s; adjusted difference [AD]=.006, P=.03). Smoothness of walking in the anteroposterior direction improved more in the motor learning than standard group for all conditions (usual: AD=.53, P=.05; narrow: AD=.56, P=.01; dual task: AD=.57, P=.04). Smoothness of walking in the vertical direction also improved more in the motor learning than standard group for the narrow-path (AD=.71, P=.01) and dual-task (AD=.89, P=.01) conditions.

Conclusions: Among older adults with subclinical walking difficulty, there is initial evidence that task-oriented motor learning exercise results in gains in the motor control of walking, while standard exercise does not. Task-oriented motor learning exercise is a promising intervention for improving timing and coordination deficits related to mobility difficulties in older adults, and needs to be evaluated in a definitive larger trial.
Archives of Physical Medicine and Rehabilitation 2015;96:388-94

Exercise interventions to improve mobility and prevent functional decline in older adults primarily target strength, flexibility, and endurance but rarely address the motor control of walking. Strength, flexibility, and endurance exercise programs that overlook the motor control of walking have resulted in only modest improvements in mobility.[1-6]

To specifically address the learning/relearning of the motor control of walking, an intervention was developed based on motor learning principles and focused on the practice of the smooth, coordinated aspects of walking throughout the gait cycle (ie, task-oriented motor learning intervention).[7-10] We previously showed that in older adults with walking difficulty (slow and variable gait), the task-oriented motor learning intervention promoted

Presented in part to the American Physical Therapy Association, January 22, 2013, San Diego, CA.

Supported by the Pittsburgh Older Americans Independence Center (grant no. NIA P30 AG024827) and the Beeson Career Development Award (grant no. NIA K23 AG026766).

Clinical Trials Registration No.: PRO09080228.

Disclosures: S.P. reports grants from InRange Systems, Inc, during the conduct of the study. The other authors have nothing to disclose.

0003-9993/14/$36 - see front matter © 2015 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2014.10.018

greater gains in clinical measures of gait (gait efficiency, gait speed, self-perceived walking ability) compared with a standard exercise program.[9] Likewise, in older adults with subclinical walking difficulty (ie, gait speed >1.0m/s but impaired skill in walking, figure-of-8 walk time >8s), the task-oriented motor learning program promoted greater gains in mobility (gait speed, walking skill) than the standard exercise program.[7]

Having shown the clinical effect of the task-oriented motor learning program, the current goal was to test the proposed mechanism of action of the intervention (eg, improved motor control of walking). Therefore, the purpose of this study was to assess the impact of a motor learning versus a standard exercise program on the motor control of gait (ie, gait variability and smoothness of walking) in community-dwelling older adults with subclinical gait deficits. Given that the motor learning program focuses on the smooth, coordinated aspects of gait timing, we expected that individuals in the motor learning exercise group would have greater improvements in gait variability and smoothness of walking than would individuals in the standard group.

Methods

Overview

The study protocol was approved by the University of Pittsburgh Institutional Review Board, and all subjects provided informed consent. The study was registered at ClinicalTrials.gov (PRO09080228). The Program to Improve Mobility in the Elderly (PRIME study) was a 12-week, single-blind randomized clinical trial that compared 2 exercise interventions in older adults with subclinical gait dysfunction. Details of the methods and the main study outcomes have been published elsewhere.[7]

Participants and inclusion criteria

Briefly, the eligible participants consisted of men and women aged ≥65 years who had subclinical gait dysfunction, defined as a gait speed ≥1.0m/s and impaired motor skill in walking.[7] Gait speed was assessed using an instrumented walkway. Motor skill in walking was assessed using the Figure-of-8 Walk Test,[11] with impaired motor skill defined as ≥8 seconds to complete the test. The Figure- of-8 Walk Test assesses walking around curves in both clockwise and counterclockwise directions. This complex task, which is associated with measures of motor control and planning,[11-14] requires smooth transitions from the timing and coordination patterns of straight-path walking to the different timing and coordination patterns of curved-path walking.[15-18] Individuals with impaired walking skill slow down and take several small steps when walking the curves of the Figure-of-8 Walk Test. Additional exclusion criteria included the following: (1) reported dyspnea at rest or during activities; (2) hospitalization in the past 6 months for acute illness or injury; (3) progressive neuromuscular disorder such as Parkinson disease; (4) persistent lower extremity or back pain; (5) fixed or fused lower extremity joints; (6) resting systolic blood pressure ≥200mmHg, diastolic blood pressure ≥100mmHg, or resting heart rate >100 beats/min or <40 beats/min; and (7) Mini-Mental State Examination[19] score <24. All participants had physician clearance to participate in a moderate-intensity exercise program.

List of abbreviations:

AP	**anteroposterior**
HR	**harmonic ratio**
ICC	**intraclass correlation coefficient**
ML	**mediolateral**
RPE	**rating of perceived exertion**
V	**vertical**

Sample size and randomization

As a pilot intervention trial, sample size (n=40) was based on feasibility within available resources rather than a given level of statistical power. The randomization sequence was generated by the study biostatistician using the high-quality pseudorandom deviate generator in SAS[a] in a 1:1 ratio and a blocked randomized scheme, and placed in sequentially numbered, sealed envelopes. Participants were assigned to motor learning or standard interventions by the study coordinator at the time of randomization.

Interventions

Overview

Both interventions were physical therapist–led, protocol-driven interventions that lasted 60 minutes twice a week for 12 weeks. The programs included a brief warmup period and strength training (ie, 30min) that was conducted on Magnum stacked weight equipment[b] and included the following exercises: knee extension, knee flexion, leg press, hip abduction, and hip extension. When subjects were able to complete 2 sets of 15 repetitions with minimal effort (ie, rating of perceived exertion [RPE] <10), resistance was increased for progression of the exercises.

Motor learning exercise

Subjects in the motor learning group also received 20 to 30 minutes of motor learning exercises in addition to the warmup and strengthening exercises. The previously described motor learning program[7,9,10] was based on the principles that enhance "skill" or smooth and automatic movement control.[20-25] The motor learning exercise program included both stepping and walking patterns. The program used goal-oriented, progressively more difficult stepping and walking patterns to promote the timing and coordination of stepping, integrated with the phases of the gait cycle. The stepping patterns were designed to shift the center of pressure posterolaterally then forward, encouraging hip extension before stepping, loading the trailing limb, coordinating activation of the abductors of the soon-to-be-swung leg with adductors of the stance limb, and shifting the center of pressure in medial stance to unload the stepping limb.[26-28] For example, to facilitate the smooth switching between agonist and antagonist muscle groups during walking, participants would practice stepping backward and across before stepping forward.

Walking patterns incorporated patterns of muscle coordination and interlimb timing into walking and were progressed by altering speed, amplitude (eg, narrowing oval width), or accuracy of performance (eg, without straying from the desired path). More complex walking patterns involved walking past others and with upper extremity object manipulation tasks, such as carrying or bouncing a ball.[25] Treadmill walking reinforced the rhythmic stepping and was completed at preferred walking speed with brief intervals of increased speed. For example, subjects would walk at their usual overground walking speed for 1 to 3 minutes; walking speed would then be increased over a 1- to 2-minute period to a maximum, comfortable, safe walking speed that would be maintained for 10 to 30 seconds. The subject's walking