ORIGINAL ARTICLE

Effect of a Gentle Iyengar Yoga Program on Gait in the Elderly: An Exploratory Study

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ABSTRACT. DiBenedetto M, Innes KE, Taylor AG, Rodeheaver PF, Boxer JA, Wright HJ, Kerrigan DC. Effect of a gentle Iyengar yoga program on gait in the elderly: an exploratory study. Arch Phys Med Rehabil 2005;86:1830-7.

Objective: To determine if a tailored yoga program could improve age-related changes in hip extension, stride length, and associated indices of gait function in healthy elders, changes that have been linked to increased risk for falls, dependency, and mortality in geriatric populations.

Design: Single group pre-post test exploratory study. A 3-dimensional quantitative gait evaluation, including kinematic and kinetic measurements, was performed pre- and postintervention. Changes over time (baseline to postintervention) in primary and secondary outcome variables were assessed using repeated-measures analysis of variance.

Setting: Yoga exercises were performed in an academic medical center (group classes) and in the subjects' homes (yoga home-practice assignments). Pre- and postassessments were performed in a gait laboratory.

Participants: Twenty-three healthy adults (age range, 62–83y) who were naive to yoga were recruited; 19 participants completed the program.

Intervention: An 8-week Iyengar Hatha yoga program specifically tailored to elderly persons and designed to improve lower-body strength and flexibility. Participants attended two 90-minute yoga classes per week, and were asked to complete at least 20 minutes of directed home practice on alternate days.

Main Outcome Measures: Peak hip extension, average anterior pelvic tilt, and stride length at comfortable walking speed.

Results: Peak hip extension and stride length significantly increased ($F_{1,18}=15.44$, $P<.001$; $F_{1,18}=5.57$, $P=.03$, respectively). We also observed a trend toward reduced average pelvic tilt ($F_{1,18}=4.10$, $P=.06$); adjusting for the modifying influence of frequency of home yoga practice strengthened the significance of this association (adjusted $F_{1,17}=14.30$, $P=.001$). Both the frequency and duration of yoga home practice showed a strong, linear, dose-response relationship to changes in hip extension and average pelvic tilt.

Conclusions: Findings of this exploratory study suggest that yoga practice may improve hip extension, increase stride length, and decrease anterior pelvic tilt in healthy elders, and that yoga programs tailored to elderly adults may offer a cost-effective means of preventing or reducing age-related changes in these indices of gait function.

Key Words: Aged; Biomechanics; Gait; Exercise; Hip; Pelvis; Rehabilitation; Yoga.

HIP EXTENSION RANGE is significantly reduced in older persons and has been strongly associated with risk for recurrent falls.[1,2] The age-related decline in hip extension is the only joint parameter to demonstrate a consistent change in elderly populations.[1,2] Reduced hip extension is accompanied by a compensatory increase in anterior pelvic tilt[1,2] and may be the primary mechanism underlying the age-related reduction in stride length, a hallmark of diminished walking performance in the elderly[1] and an important predictor of falls, dependency, institutionalization, and mortality in elderly populations.[3-7] Interventions that can reverse or attenuate these age-related gait changes may thus not only increase mobility, autonomy, and quality of life (QOL), but also help reduce the morbidity and mortality associated with falls in the elderly.[8]

Of particular interest in this regard is yoga, an ancient Indian discipline of the body, mind, and spirit, dating back to at least 2000 BC, that is gaining increasing popularity in Western industrialized countries as a means of alleviating stress and improving balance, flexibility, and muscle strength.[9-11] Yoga is simple to learn and can be practiced even by very elderly, ill, or disabled persons.[12] Requiring little equipment and personnel to sustain, yoga may offer an especially promising and cost-effective means of reducing impairment associated with gait problems in the elderly. Yoga exercises are routinely used in India to manage joint contractures caused by poliomyelitis and other disorders.[13,14] Yoga programs have also been shown to improve balance and coordination in elderly patients with stroke,[15] and to improve grip strength,[16-19] reduce pain,[17,18] and increase range of motion (ROM)[17,19] in people with rheumatoid arthritis,[16,19] osteoarthritis,[17] and carpal tunnel syndrome.[18] In a small, uncontrolled U.S. study of healthy young adults, Tran et al[20] found that yoga increased both isokinetic and isometric muscle strength and improved joint flexibility. Similarly, controlled studies of healthy children and adults in India have shown yoga to increase grip strength[16] and to enhance flexibility and joint extension.[21]

A growing body of research suggests that yoga-based interventions are readily accepted by older adults, and may improve a range of health outcomes in elderly populations. Yoga programs have been shown to enhance mood[22-26] and QOL[22,27] and to reduce fatigue,[25] sleep disturbance,[27] symptoms of stress,[27,28] and somatic complaints[22,28] in elderly persons; and to improve metabolic and physiologic profiles, to reduce med-

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Supported by National Center for Medical Rehabilitation and Research (NCMRR) (grant no. NIH HD01351) and the National Center for Complementary and Alternative Medicine (NCCAM) (grant no. NIH K30-AT-00060). The contents of this article are solely the responsibility of the authors and do not necessarily represent the official views of NCMRR or NCCAM.

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit upon the author(s) or upon any organization with which the author(s) is/are associated.

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0003-9993/05/8609-9667$30.00/0
doi:10.1016/j.apmr.2005.03.011

ication use, and to enhance health outcomes in older adults with cardiovascular disorders[23,26,28] or diabetes.[1,29] To our knowledge, however, no published studies to date have examined the potential beneficial effects of yoga on age-related gait changes in older adults.

In this preliminary study, we examined the influence of a gentle Iyengar Hatha yoga program on key markers of gait impairment in a sample of healthy elderly subjects. Specifically, we tested the hypothesis that a gentle 8-week yoga program designed to increase lower-body strength and flexibility would increase peak hip extension, reduce anterior pelvic angle, and increase stride length—important determinants of gait function and stability in the elderly. We also evaluated the secondary hypotheses that structured yoga practice would improve other, age-related indices of gait function, including comfortable walking speed, peak ankle plantarflexion, and peak ankle joint power generation.

METHODS

Healthy, nonobese adults aged 62 and older and naive to yoga were recruited through advertisements in university publications and flyers displayed in senior centers, grocery stores, buses, and other public places. Eligibility to participate in the study was determined by screening questionnaires and physical examination. Exclusion criteria included an asymmetric gait pattern, use of an assistive device for walking, evidence of neuromuscular illness, major orthopedic diagnosis in the lower back, pelvis, or lower extremities, severe rheumatoid arthritis or osteoarthritis that would cause discomfort during the yoga exercises, acute medical illness, and symptomatic heart or lung disease. Because excessive soft tissue reduces the reliability of marker placement and kinematic measurement, obese individuals (body mass index [BMI], $\geq 30 kg/m^2$) were excluded from the study. The study was approved by the University of Virginia School of Medicine Institutional Review Board and informed consent was obtained from all who volunteered for enrollment. Twenty-three participants were enrolled in the yoga exercise program, 19 of whom completed the 8-week course. Three enrollees discontinued after 1 (n=2) or 2 (n=1) sessions, reporting that the room was too crowded or the exercises too challenging. One participant, who cited high satisfaction with the program, left after the fifth yoga class because of unexpected family obligations. Those who discontinued the study did not differ from those completing the study in age (71.75 ± 2.7y vs 70.7 ± 1.37y; $t=.33$, $P=0.7$), BMI ($25.6 \pm 1.1 kg/m^2$ vs $26.0 \pm 0.7 kg/m^2$, $t=0.2$, $P=0.9$), or sex distribution (Fisher exact test, $P=0.5$).

Participants attended two 90-minute Iyengar Hatha yoga classes each week, and were asked to complete a minimum of 20 minutes of yoga practice at home every other day (5 times/wk). Each group session included a standard yoga routine of gentle, supervised Hatha yoga postures and breathing exercises designed for beginners and specifically tailored for elderly persons. Props (blankets, chairs, blocks) were used as needed to support participants in any yoga positions that were difficult or uncomfortable for them and to minimize risk of overstretching or injury. Each session began with yoga warm-up and centering poses, followed by a series of more active yoga exercises. Yoga breathing exercises (Pranayama) were performed in conjunction with specific seated and supine poses. Every session terminated with standard yoga relaxation exercises, including shavasana (corpse pose). Yoga postures in the program included: centering (in cross-legged position), finger and toe weaving, virasana (hero pose), vajrasana (thunderbolt pose), tadasana (mountain pose), table pose (including leg-lifts), salabasana (locust pose), padangusthasana (holding the big toe pose), supta padangusthana (holding the big toe lying down pose), uttitha hasta padangustasana (extended holding the big toe pose), supta baddha konasana (lying down bound angle pose), eka pada bhekasana (1-leg frog pose), and shavasana (corpse pose). Poses specifically targeting the pelvic region were incorporated into each session. These included rajakapotasana (pigeon or hip stretch pose; fig 1), parsvotanasana (flank stretch; figs 2, 3), virabhadrasana (warrior pose), and surya namaskar (modified sun salutations using a chair, see fig 4; or a prop, see figs 5, 6).

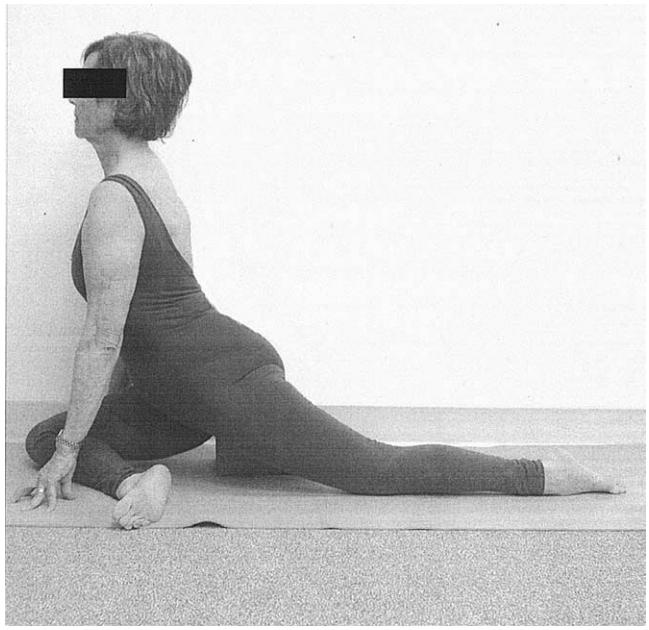

Fig 1. Hip stretch pose.

Home practice sessions alternated between 2 standard beginner yoga routines, each comprising a subset of the group session poses and exercises. Participants received detailed, illustrated homework assignments after each group yoga class to assist them with their home practice sessions, and completed daily logs to monitor frequency and duration of practice, and to document problems, progress, and other experiences with their home sessions.

Study participants underwent a full pelvic and lower-extremity kinematic and kinetic evaluation while standing and walking at comfortable walking speeds within the week before and after the 8-week exercise program. The kinematic and kinetic gait study was performed at the University of Virginia Department of Physical Medicine and Rehabilitation's Gait and Motion Analysis Laboratory by an evaluator who was blinded to each participant's preyoga intervention values. Subjects were asked first to stand and then walk along a 10-m walkway and kinematic and kinetic data from 3 complete gait strides were recorded. A 10-camera video-based motion analysis system (Vicon 624 system)[a] was used to measure the 3-dimensional position of infrared reflective markers, at 120 frames/s, attached to the following bony landmarks on the pelvis and lower extremities during walking: bilateral anterior superior iliac spines, lateral femoral condyles, lateral malleoli, forefeet, and heels. Additional markers were placed over the sacrum and rigidly attached to wands over the midfemur and midshank. Pelvic and joint angular motion were reported in reference to a comfortable barefoot standing condition, with zero defining the averaged standing joint angle.