Original Research

Effects of Backward Walking on Hamstring Flexibility and Low Back Range of Motion

CHET R. WHITLEY*[1] and JANET S. DUFEK‡[2]

[1]Arizona School of Health Sciences Department of Physician Assistant Studies
A.T. Still University, Mesa, AZ, USA

[2]Biomechanics Laboratory / Sports Injury Research Center
Department of Kinesiology and Nutrition Sciences, University of Nevada, Las Vegas; Las Vegas, NV, USA

‡Denotes professional author, *Denotes undergraduate student author

ABSTRACT

Int J Exerc Sci 4(3) : 192-198, 2011. The purpose of the study was to examine the effects of backward walking on hamstring flexibility and low back range of motion. Ten healthy female volunteers (29.9±10.0 yr; 165.1±8.2 cm; 68.53±18.4 kg) completed pre-post laboratory testing surrounding a 4-week intervention of backward walking. During the pretest, each participant walked forward on a treadmill at a preferred velocity for 3-5 min. A biaxial electrogoniometer was secured externally to the low back and a sit-and-reach test was performed. Each participant then walked backward at their preferred pace on a treadmill for 10 min, during which time low back motion data were obtained (1000 Hz). Following the pretest, participants completed an intervention of walking backward at a self-selected velocity for 10-15 min/day, 4 days/week. This was followed by a posttest, using the exact protocol as the pretest. Dependent variables consisted of pre-post measures of: 1) backward walking velocity (VEL), 2) flexibility of the hamstrings (HF), low back sagittal plane range of motion (sROM), and low back coronal plane range of motion (cROM). Correlated t-tests ($\alpha = 0.05$) with Bonferroni correction identified significant ($p < 0.001$) differences in VEL and HF. Low back motion parameters (sROM, cROM) were not significantly different ($p > 0.0125$) following the intervention. Results of the study suggest that a 4-week intervention of backward walking appears to provide an appropriate stimulus for an increase in flexibility of the hamstrings. A possible interaction between VEL and sROM or cROM limited the interpretation of observed non-significant changes in low back motion.

KEY WORDS: Hamstring insufficiency, low back pain, rehabilitation, retro locomotion, spine

INTRODUCTION

Backward walking is an activity that results in joint kinematic patterns different from those experienced during forward walking (14). An important difference is the pre-stretch of the hamstrings that occurs in backward walking prior to thigh reversal due to greater hip flexion and lesser extension (2, 3). This observation supports the conjecture that hamstring flexibility and perhaps low back flexibility may increase when walking backward, positing this form of exercise as a possible means to reduce tightness in the hamstrings and as a mechanism to reduce low back pain (LBP) for persons experiencing this condition.

Reduced flexibility and limited motion of the low back is often a result in individuals who experience LBP, thus limiting function. Low back pain is the fifth most common reason for physician visits in the U.S., (5) and it is further reported that 60% to 80% of the U.S. population will experience LBP at some point in their lives (15). One of the primary goals during therapeutic exercise for individuals suffering from LBP is to achieve adequate flexibility and range of motion of the spine (13). In addition, by lengthening and stretching the lumbar spine, disc compression can be reduced, resulting in a change in pelvic tilt which has been suggested to influence hamstring flexibility. Research has shown that inflexible hamstring muscles limit anterior tilt of the pelvis during trunk flexion, and this limitation can result in increased lumbar muscle and ligamentous tension, producing considerably greater compressive stress on the lumbar spine (7, 9).

Backward walking is a translatory and dynamic activity with documented cardiovascular benefits (4, 6). In our study, however, we sought to examine whether backward walking could elicit benefits relative to flexibility of the hamstrings. We were also interested in examining whether backward walking might alter motion of the low back. Therefore, the specific purpose of the study was to examine the effects of backward walking on hamstring flexibility and low back range of motion in an effort to provide a stimulus for persons suffering from LBP.

METHODS

Participants

Ten healthy female volunteers (29.9 ± 10.0 yr; 165.1 ± 8.2 cm; 68.53 ± 18.4 kg) with no history of LBP were recruited for the study. Persons with acute lower extremity injuries, previous hamstring injuries, or those who had undergone back surgery or hip arthroplasty were excluded from participation. There was no gender exclusion stated during volunteer recruitment; the first 10 individuals who met inclusion criteria were enrolled into the study. The experimental protocol was verbally explained and, prior to participation, all volunteers granted written consent to participate in accordance with policies established for the protection of human subjects at the affiliated institution.

Protocol

Data were obtained from all study participants prior to and following a 4-week backward walking intervention program using the same pre-post experimental protocol. The protocol consisted of a 3-5 min warm-up walking forward on a treadmill at a self-selected velocity. A biaxial electrogoniometer (Biometrics, Model SG150) was then secured externally to the low back vertically spanning T12-S2 (Figure 1). The YMCA Sit-and-Reach Test was next performed to measure low back and hamstring flexibility (1). This test was administered following YMCA recommended procedures. Specifically, a measuring tape was placed on the floor and a line placed perpendicular to the tape at 38 cm, establishing a consistent reference for all participants. With shoes off, the participant sat on the floor and aligned their heels to this line. Placing one hand on top of the other, instructions were given to keep hands on the measuring tape and slowly bend forward, keeping the back straight. To maintain consistency in measurement among participants, the same investigator (C.R.W.) performed each sit-and-reach measurement. The greatest displacement value over three repetitions of the test was retained for analysis, per YMCA recommended procedures. During execution of this test, shoulder motion was visually assessed to minimize scapular protraction, and any trials which exhibited shoulder protraction to improve the reach score were discarded. This was an infrequent occurrence across all tests.

Participants then walked backward on a treadmill at their preferred velocity for 10 min. Velocity was established by communicating with the subject if the treadmill pace was comfortable and if they could maintain this velocity for 10 min. The selected walking velocity was recorded. The participant was blinded to the treadmill speed, as they were facing away from the treadmill consol. Electrogoniometer data (1000 Hz) were obtained for 30 s during the 6th min of backward walking (8) to assure accommodation to the treadmill and steady state of performance prior to data collection.

Intervention

Following the pretest, participants completed 4 weeks of backward walking on a treadmill or overground for 10-15 min per day, 4 days per week. Velocity was self-selected; however participants were encouraged to walk as fast as they could on a daily basis. All participants agreed to continue their current level of activity and not to modify the activities they were currently performing. Study participants were contacted on a weekly basis to report compliance. In addition, participants also completed a backward walking and activity log to be turned into the investigators at the conclusion of the intervention to validate both additional activity consistency as well as backward walking activity compliance. At the conclusion of the intervention, participants returned to the laboratory for posttesting, which was completed using the same protocol as that of the pretest.

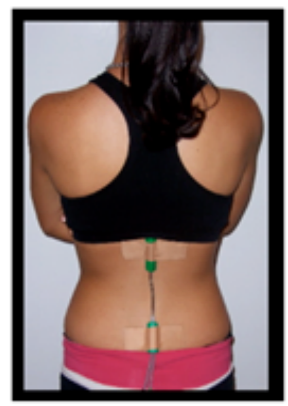

Figure 1. Illustration of electrogoniometer placement spanning the low back.

Statistical Analysis

Dependent variables included backward walking velocity (VEL), the YMCA Sit-and-Reach Test score as a measure of hamstring flexibility (HF), sagittal plane range of motion of the low back (sROM; flexion-extension), and the coronal plane range of motion of the low back (cROM; lateral bending). Low back motion data (sROM, cROM) were obtained for each participant by calculating the average value across 10 successive walking strides during the 30 s data capture for each test session.

Correlated t-tests (α = 0.05) were used to test pre-post differences for each of the four dependent variables. A Bonferroni correction was applied to reduce the likelihood of committing a Type-I statistical error, resulting in an effective α = 0.0125 for each of the four statistical comparisons. All statistical tests were conducted using SAS 9.1 software (SAS Institute 2002-2003, Cary, NC).

RESULTS

Mean and standard deviation values by condition are presented in Table 1. There was a significant increase observed from pre- to posttest for VEL ($t = 6.22$, $p < 0.001$) and HF ($t = 5.47$, $p < 0.001$). Results by participant are presented graphically in Figures 2 and 3, respectively. Low back range of motion parameters (sROM, cROM) were not significantly different across the group ($p > 0.0125$), however differential responses were observed on an individual basis (Figures 4-5).

Table 1. Pre-Post Mean ± Standard Deviation Values by Test Session.

Variable	Pre-Intervention (n = 10)	Post-Intervention (n = 10)
VEL (m/s)	**0.51 ± 0.11**	**0.81 ± 0.23**
HF (cm)	**40.1 ± 10.5**	**43.2 ± 10.3**
cROM (deg)	5.2 ± 1.9	4.6 ± 2.0
sROM (deg)	15.6 ± 7.0	13.7 ± 5.1

Bold values: Significant difference ($p < 0.001$) between test sessions.

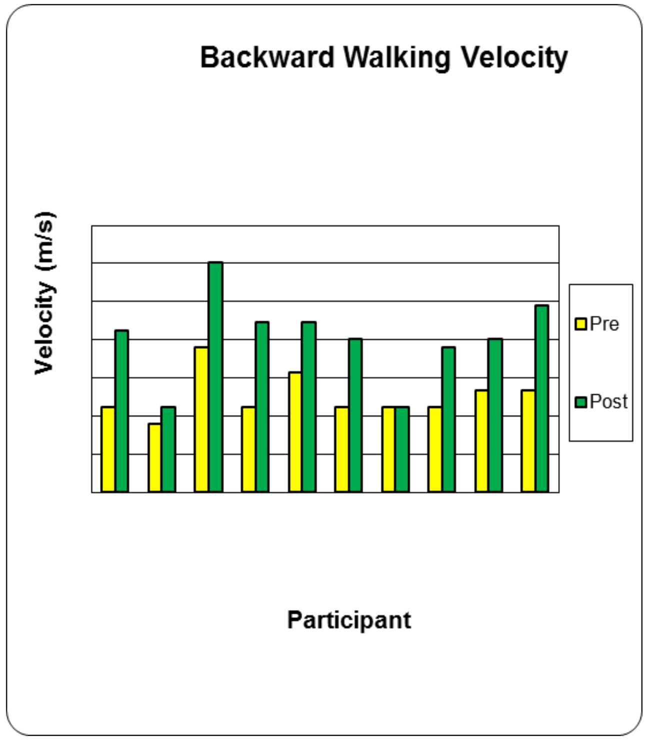

Figure 2. Pre-Post VEL by participant. Group results for VEL identified significant ($p < 0.001$) differences between test sessions.

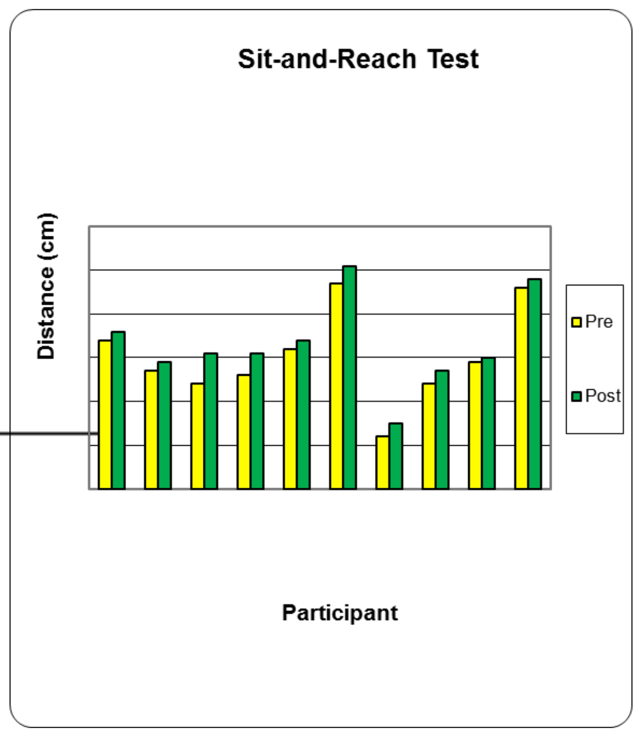

Figure 3. Pre-Post HF values by participant as measured by the YMCA Sit-and-Reach Test. Group results for HF identified significant ($p < 0.001$) differences between test sessions.

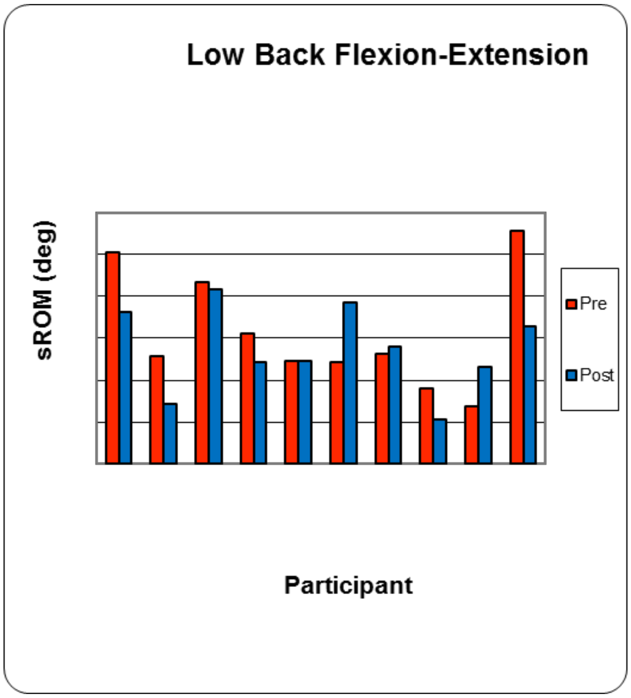

Figure 4. Pre-Post sROM values by participant. Group results for sROM did not identify significant ($p > 0.0125$) differences between test sessions.

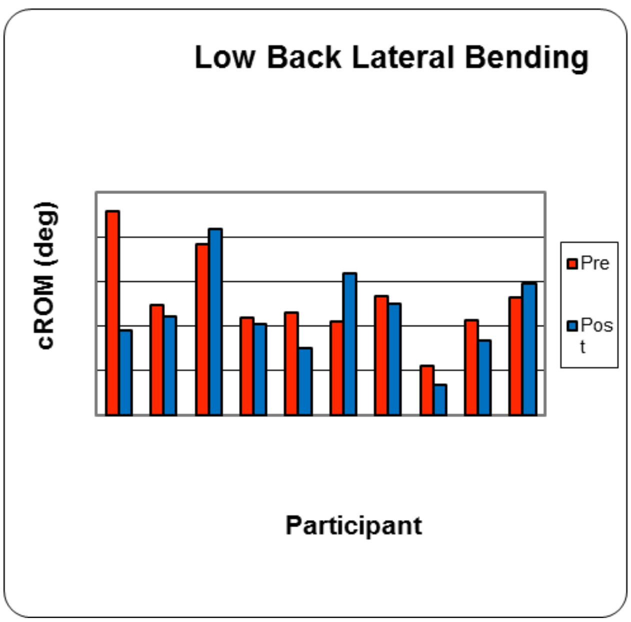

Figure 5. Pre-Post cROM values by participant. Group results for cROM did not identify significant ($p > 0.0125$) differences between test sessions.

DISCUSSION

This study sought to assess the effectiveness of a backward walking training program on hamstring flexibility and low back range of motion with possible implications for individuals experiencing LBP. Results of the study indicated that nine out of 10 of the participants increased VEL following the intervention. Whether the general increase in backward walking velocity was the result of a neurological adaptation to the novel task or a muscular response to the intervention is unclear. However, it is clearly apparent that as a group, there was a significant ($p < 0.001$) increase in HF as measured by the YMCA Sit-and-Reach Test, with all participants showing an increase in reach distance following the backward walking intervention. The average increase across the group was 3.1 cm, suggesting the effectiveness of the intervention in increasing HF. It is unlikely that this was a 'learning effect' as could be argued for the change in VEL, since participants did not regularly practice the Sit-and-Reach Test. However, extraneous kinematic motion which could influence the HF measurement (i.e., shoulder protraction) was not documented, but visually controlled for during data collection.

Furthermore, non-significant group results were observed regarding low back ranges of motion for both sROM and cROM. Most individuals decreased ROM values in both planes of motion, yet some individuals displayed increases which could possibly be attributed to the intervention (Figures 4-5). A confounding aspect in the interpretation of the low back motion results could be the concomitant observed changes in VEL between conditions. The average group differences between test sessions for sROM and cROM were 1.9 and 0.6 deg, respectively, with the latter effectively being outside the limits of accuracy of the electrogoniometer used in the study. Given the sagittal nature of walking, one would anticipate greater changes in flexion-extension values versus lateral bending. But differences between maximum flexion and extension positions were not documented, only total range of motion. Knowledge of the specific position of the trunk relative to the pelvis could be of importance relative to the pre-stretch necessary to perform backward walking. This area of inquiry is suggested as an extension of the current research.

The beneficial effects of acute static stretching, either pre- or post-exercise, have been reported (10, 11, 12). Such research has focused on the effects of stretching on performance, such as increased jump height (10, 12) versus the effects of a dynamic stretching activity (backward walking) on functional outcome. The focus of this investigation was on the possible effects of a participatory activity versus static or dynamic stretching on the ability to influence hamstring flexibility and low back motion characteristics, with the potential to reduce LBP. The results suggest that backward walking may provide such a stimulus.

The results of this preliminary study also suggest that backward walking may positively influence hamstring flexibility for females. It is unknown if a similar result might be obtained for males or for specific patient populations. Because the individual participants in the current study had no history of LBP, we are not able to state any empirical relationships between backward walking and LBP symptoms. Given the suggestive results of this preliminary investigation, this is an area of inquiry that deserves further research.

There is an accepted relationship between LBP and flexibility of the hamstrings (9) and it has been conjectured that an increase in the latter could possibly decrease LBP. This study presents preliminary information suggesting that a 4-week program of backward walking may provide an appropriate stimulus to increase flexibility of the hamstrings in healthy females. Further research is required to ascertain whether this intervention can also serve as a means to reduce LBP as well as whether similar results can be observed in alternative participant populations.

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