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Original Article

Effects of Inclined Treadmill Walking on Pelvic Anterior Tilt Angle, Hamstring Muscle Length, and Trunk Muscle Endurance of Seated Workers with Flat-back Syndrome

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Abstract. [Purpose] This study investigated the effects of inclined treadmill walking on pelvic anterior tilt angle, hamstring muscle length, and back muscle endurance of seated workers with flat-back syndrome. [Subjects] Eight seated workers with flat-back syndrome who complained of low-back pain in the L3–5 region participated in this study. [Methods] The subjects performed a walking exercise on a 30° inclined treadmill. We measured the pelvic anterior tilt angle, hamstring muscle length, and back muscle endurance before and after inclined treadmill walking. [Results] Anterior pelvic tilt angle and active knee extension angle significantly increased after inclined treadmill walking. Trunk extensor and flexor muscle endurance times were also significantly increased compared to the baseline. [Conclusion] Inclined treadmill walking may be an effective approach for the prevention or treatment of low-back pain in flat-back syndrome.
Key words: Inclined treadmill walking, LBP, Seated workers

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INTRODUCTION

Sitting for long periods of time places stress on the lumbopelvic region, reduces the circulation of blood in the lower extremities, and may result in muscle shortening, muscle weakness, or hypo-mobility of the joints[1)]. O'Sullivan et al.[2)] showed that decreased trunk muscle endurance is associated with reduced activity levels and habitual adoption of a passive sitting posture. Most seated workers adopt a relaxed or slumped sitting posture during long hours of desk work[3)]. Flat-back syndrome decreases normal lordosis of the lumbar spine, causes posterior movement of the nucleus pulposus, and increases the diameter of the intervertebral foramina[4)]. When walking, the muscles of the posterior oblique sling provide trunk stability for extension and work together to help deliver power from the lower body to the upper body[5)]. The posterior oblique sling links the hamstring, gluteus maximus, thoracolumbar fascia, and contralateral latissimus dorsi, in sequence[5)]. Relatively high demands are placed on hip extensor muscles while climbing a mountain[4)]. Therefore, this study investigated the effect of inclined treadmill walking on pelvic anterior tilt angle, hamstring muscle length, and back muscle endurance of seated workers with flat-back syndrome.

SUBJECTS AND METHODS

Eight seated workers (five males and three females) with flat-back syndrome who complained of low-back pain (LBP) in the L3–5 region participated in this study. Their average age, height and weight were 28.36 ± 1.3 years, 170.8 ± 6.6 cm, and 68.5 ± 5.1 kg, respectively. They had complained of low-back pain or stiffness present for at least 3 months, and examination revealed flat-back posture in the lumbopelvic region. None of the subjects had undergone any specific treatment for this condition. All the subjects had mechanical LBP without radiating pain. Forward flexion in the standing position with the knees fully extended caused pain or stiffness in the lower back. All participants gave their informed, written consent according to the protocol approved by the Yonsei University Faculty of Health Science Human Ethics Committee.

Anterior pelvic tilt was measured by placing the caliper tips of a palpation meter (PALM, Performance Attainment Associates, St. Paul, MN, USA) on the ipsilateral ASIS and PSIS. The PALM consists of two caliper arms and an inclinometer. It provides a valid, reliable, and cost-effective clinical measurement tool for the calculation of discrepancies between landmarks. Anterior and posterior pelvic tilts are defined as positive (+) and negative (−) tilt angles, respectively.

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The active knee extension (AKE) test was used to evaluate the hamstring muscle length of the dominant lower limb. Each subject was placed in the supine position. The measured leg was then flexed 90° at the hip and knee on an adjustable support table, and the contralateral leg was fixed to the table with a strap across the thigh. A ruler with an inclinometer was attached to the line between the lateral femoral epicondyle and the lateral malleolus and adjusted to zero degrees in the test position. Subjects were then asked to extend the flexed leg while relaxing the ankle. The test was concluded when the subject could feel resistance in the stretched hamstring muscle. At that point, the hamstring muscle length, as indicated by the AKE angle, was measured by the digital inclinometer.

The trunk extensor endurance test measured the time subjects could hold the extended spine horizontal to the table surface with the thighs, knees, and ankles supported on the table (Biering–Sørensen test). The trunk flexor endurance test involved positioning the subject on a plinth with the back resting on a wedge that maintained it at 60° flexion from the horizontal. The knees were flexed to 90°, and the feet secured with a seat belt. The time this posture could be held was measured. The subjects were asked to walk on a 30° inclined treadmill at a speed of 1.5 km/h for 15 minutes. They performed two sets of walking exercises per day for one week. Muscle fatigue was avoided by providing a 10-min rest interval between sets. A tester measured pelvic anterior tilt angle, hamstring muscle length, and back muscle endurance before and after the inclined treadmill walking.

Statistical analysis was performed using the SPSS statistical package (version 14.0, SPSS, Chicago, IL, USA). The paired t-test was used to detect statistically significant differences between the parameters measured before and after inclined treadmill walking.

RESULTS

Anterior pelvic tilt angles were significantly increased after inclined treadmill walking, measuring 6.7 ± 1.8° and 6.1 ± 1.5° on the right and left sides, compared to the baseline angles of 2.0 ± 2.3° and 1.6 ± 1.4°, respectively ($p < 0.05$). The AKE angle was also significantly increased after inclined treadmill walking (45.7 ± 4.3°) compared to the baseline value (38.0 ± 4.4°) ($p < 0.05$). After inclined treadmill walking, trunk extensor muscle endurance time was significantly increased compared to the baseline (65.1 ± 10.0 s vs. 47.0 ± 6.8 s), as was trunk flexor muscle endurance time (45.0 ± 6.9 s vs. 28 ± 6.9 s) ($p < 0.05$).

DISCUSSION

A previous study reported that hamstring shortening was associated with a reduction in lumbar spine flexion, contributing to LBP[6]. A shortened hamstring muscle pulls the ischial tuberosity in the inferior direction during forward bending, thereby reducing anterior tilting motion of the pelvis[7]. This study demonstrated that the pelvic anterior tilt and AKE angles increased after walking on an inclined treadmill.

Adequate trunk muscle endurance may play an important role in injury-free performance[2, 8]. In this study, subjects were considered to have failed the trunk extensor and flexor muscle endurance tests if their scores were less than 60 s and 50 s, respectively[9]. The literature suggests that sufficient trunk muscle endurance contributes to spinal stability during prolonged, strenuous physical tasks[8]. This study showed increased trunk muscle endurance after inclined treadmill walking.

Inclined treadmill walking stretches the hamstring muscles, continuously co-activities the trunk muscles, and mobilizes of the pelvis through repetitive trunk and pelvic flexion. Therefore, we anticipate that inclined treadmill walking may be an effective approach for prevention or treatment of LBP in flat-back syndrome.

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