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Original Article

Effect of Wearing a Tight Waist Belt on the Sagittal Kinematics of the Pelvis during Sit-to-Stand

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Abstract. [Purpose] The purpose of the present study was to evaluate the effect of a tight waist belt on the human musculoskeletal system by assessing sagittal pelvic kinematic data during the sit-to-stand (STS) maneuver. [Subjects] Twelve asymptomatic males were recruited and three belt conditions were used during the STS. Sagittal kinematic data of pelvic motion were collected using a 3D motion-capture device [Results] The changes of the anterior pelvic tilt during the STS were significantly greater in the tight waist-belt condition than in the no-belt condition. [Conclusion] The results of this study show that wearing a tight waist belt increases anterior pelvic motion.
Key words: 3D-kinematic, Pelvic Instability, STS

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INTRODUCTION

Sit-to-stand (STS) is a frequently performed movement in independent living. Dall and Kerr (2010) reported that STS is the most frequent movement of sedentary workers[1)]. If the STS is disturbed by improper technique or factors restraining the human musculoskeletal system, repetitive movement of STS might contribute to prevalence of musculoskeletal dysfunction[2, 3)]. General usage of waist belt is to emphasize a slender waist as well as to hold pants at the waist level. The wearing tight garments could be a risk factor for digestive problems, increasing the incidence of bowel discomfort[4)]. However, the influence of a general waist belt on the musculoskeletal system has not yet been investigated. We hypothesized that wearing a tight-fitting waist belt, which is commonly done in daily lives, influences the human musculoskeletal system during STS, forcing the abdominal muscles to work together differently, creating different functional synergies. The purpose of this study was to determine the effects of the tightness of a general waist belt on pelvic kinematics during the STS.

SUBJECTS AND METHODS

This study subjects were 12 healthy male students aged 20–27 years (23.8±5.7 years, mean±SD), whose height and weight were 175.4±5.2 cm and 66.1±2.1 kg, respectively. Subjects with conditions that might have affected trunk mobility, such as injury or neurological deficits of the hip and lower extremities, during the previous one year, were excluded from the study. The subjects provided their informed consent before participating in this study. This study was approved by the Inje University Faculty of Health Sciences Human Ethics Committee. The general waist belt used in this study was made of layers of leather and had an adjustable buckle; the width and thickness of the belt were 3 cm and 3 mm, respectively. The tightness of the belt was adjusted using the circumference of each subject's waist. There were three belt conditions in this study: no belt, the belt tightened to 100% of the patient's waist circumference, and the belt tightened to 90% of the patient's waist circumference. Kinematic data were recorded during STS. Data were collected at a sampling rate of 100 Hz with a motion-capture system (Vicon MX, Oxford Metrics, Oxford, UK) that consisted of eight infrared cameras. The kinematic data were smoothed using a Woltring filter. Sixteen reflective markers were attached to the lower body according to the Plug-in-Gait Marker Set (Oxford Metrics) using double-sided tape. The software used for kinematic data collection was Nexus 1.4.1 (Oxford Metrics) and the data were analyzed with Polygon 3.1 software (Oxford Metrics). The experimental protocol required the completion of two STS trials for each of the three belt conditions. The test order was randomized. The initial erect sitting posture was that described in a previous study[5)]. Each subject was asked to stand up at a self-selected speed from the seated position with an erect-spine posture. The phase of the STS commenced when the right pelvis was flexed at least 0.1° anteriorly, and ended when the right pelvic angle was maintained for at least three frames (0.03 s) in the standing posture, or when the reduction in the right pelvic angle had stopped. The STS movement cycle

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for time normalization is expressed as STS from movement onset, 0% to end, 100%. Values were determined for each 2% of the movement, beginning at 0%[6]. The change in pelvic angle was calculated as the difference between the maximal pelvic flexion angle and the initial pelvic angle. The subjects were given 3 min of practices and 1 min of rest prior to each data acquisition trial. For the analysis, we used a within subject design, and one-way repeated-measures ANOVA was conducted to test for differences in pelvic kinematic values during the maneuver. Significant main differences appearing in pairwise multiple comparison, were treated with the Bonferroni correction to identify specific differences. Significance was accepted for values of $p<0.05$, and SPSS version 12.0 (SPSS, Chicago, IL, USA) was used for statistical analyses.

RESULTS

The change in the anterior tilt of the pelvic angle differed significantly with the tightness of the waist belt during the STS maneuver. The change in the anterior tilt of the pelvis was significantly greater in the 90% waist belt condition (36.6 ± 6.0°) than in the no-belt condition (33.3± 6.1°), but it did not differ significantly between the no-belt condition and 100% waist belt condition (33.1 ± 4.8°) ($p<0.05$).

DISCUSSION

Theoretically, STS is the initiation of flexion of the trunk and hips to bring the center of mass forward, followed by symmetrical extension of the lower-limb joints and trunk extension to raise the body mass in a vertical direction over the feet[6]. Wearing a tight waist belt increased the change in anterior pelvic tilt that occurs during STS. A possible explanation for this is that the tight waist belt might have increased abdominal pressure by narrowing the waist circumference, which might have decreased the space within the abdominal cavity. Elevated abdominal pressure has been shown to cause multi-directional stiffness of the spine[7, 8]. Tightness of a waist belt might restrict forward movement of the center of mass, increasing pelvic inclination through a compensatory mechanism. This mechanical change would increase the lever arm between weight and fixed foot necessitating a greater force for extension of the knee joint. Habitual STS while wearing a tight belt may nterrupt normal lumbo-pelvic coordination as well as increase the load on the knee joint, contributing to muscle imbalance. Increased abdominal pressure due to a tight waist belt might counteract the required contraction of the erector spinae. A previous study, using a wide belt, reported that the intramuscular pressure on the erector spinae influenced spinal stiffness separately from muscle activation[9]. Although a narrow belt did not completely restrict trunk movement, pressure elevated by the tightness contributed to spinal stiffness.

Our results indicate that wearing a tight waist belt may contribute to the development of excessive anterior pelvic tilt. However, the present study did not conduct against specific skeletal structure, and was conducted with young adult males with a normal body mass index. The effects of tight waist belts need to be investigated in further studies with female subjects and subjects with obesity.

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