Sagittal Kinematics of the Lumbar Spine and Pelvis while Walking on High Heels

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SUMMARY
This study aimed to investigate the kinematic profiles of the lumbar spine and pelvis, and muscular activities of the lower back and abdominal muscles while walking on high-heeled shoes in young women. Eight female college students were asked to walk on a flat floor at a free walking speed while wearing heels of 4 heights (0, 3, 6, and 9 cm). Sagittal angular displacements of the lumbar spine and pelvis and the surface electromyographic (EMG) activities of the lower trunk muscles were recorded. Kinematically, the sagittal range of motion of the pelvis during the stance phase was significantly larger while walking on high heels than while walking on low heels (p < 0.05), while there was no marked difference in the lumbar angular displacement. Little findings were seen regarding the muscular activities of the lower trunk muscles. The results suggest that high heels result in an alternation of the pelvic range of motion in the sagittal plane. However, the influence of high heels would be absorbed by movement of the lumbar spine to maintain individual walking characteristic.

INTRODUCTION
Kinematic and kinetic differences while walking on flat and high heels was investigated to assess relation to low-back pain, and age or experience of the wearers [1,2]. There are several studies on hip, knee, and ankle joint movement in association with EMG activities, but few studies spinal and pelvis movement and EMG activities of the trunk muscles. The purpose of this study was to investigate the sagittal kinematics of the lumbar spine and pelvis in relation to the activities of the lower trunk muscles while walking on heels of different heights.

METHODS
This study included 8 healthy female volunteers (mean age, 18.6±0.7 years; height, 155.1±5.1 cm; weight, 52.3±4.9 kg) with no history of orthopaedic problems. The study protocol was approved by the Human Research Ethic Committee of Tokyo University of Technology, Tokyo, Japan. Prior to their participation, the subject were asked to read the information sheet and sign the consent form. Sagittal movement of the lumbar spine and pelvis while walking was measured by using a three-dimensional motion analyzer, VICON Nexus (Oxford Metric). This instrument has 6 infrared cameras and 4 force plates. Infrared light-emitting 35-round markers set (plug-in gait) were attached to the subject’s skin by using sticky tape. The sampling frequency was set at 100 Hz. The EMG activities of the right external oblique, iliocostalis, and multifidus muscles were recorded by using disposable bipolar surface electrodes during the stance phase. The EMG signals were sampled at 1000 Hz, and then synchronized with the kinematic data.

The range of motion of the pelvis and the lumbar spine between maximal extension and flexion during the stance phase were analyzed using the Polygon report and excel files. The EMG signals were filtered, rectified, and smoothed to obtain an integrated electromyogram (iEMG). A critical alpha value of 0.05 was used to determine statistical significance when comparing the Kruskal–Wallis test results for each walking exercise with heels of different heights.

RESULTS AND DISCUSSION
Walking on high heels resulted in a significant increase of the sagittal angular displacement of the pelvis during the stance phase (p < 0.05). However, there was no specific change in the lumbar angular displacement when walking on heels of different heights. The EMG activities of the lower trunk muscles recorded during the stance phase were similar when walking on heels of 4 different heights. The use of high heels results in postural change to accommodate the kinematics of proximal body segments to the foot [3]. The range of motion of the pelvis in the sagittal plane is slightly lower while walking on high heels (6.1 cm) than while walking on low heels (1.6 cm) [3]. Further study is required to examine the compensation mechanism that occurs while walking on high heels.

Figure 1: Range of motion of the lumbar spine and pelvic in sagittal plane while walking on heels of 4 different heights.
CONCLUSIONS
The use of high heels alters the pelvic range of motion in a sagittal plane but not movement of the lumbar spine.

REFERENCE