THE INFLUENCE OF KNEE FLEXION CONTRACTURE ON TRUNK KINEMATICS DURING GAIT
- A BIOMECHANICAL STUDY ON KNEE-SPINE SYNDROME -

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INTRODUCTION
Severe knee osteoarthritis often causes knee flexion contracture, which deteriorates patient’s activity of daily living. In addition, the contracture influences the physiological movements of other parts of the body, not only hip and ankle joints but also spine.

The purpose of the current study was to investigate the effect of knee flexion contracture on trunk kinematics during gait.

METHODS
Ten healthy old women, with the age of 60-64 (average 62) years, participated in the current study. Each subject had no surgical history of lower extremity and no pain around the knee. After an informed consent, subjects were tested at the laboratory with use of gait analysis system which consisted of twelve retro-reflective markers, five cameras (Pro-reflex, Qualisys) and a force plate (AM6110, Bertec). Unilateral (only right side) knee flexion contractures of 0 degrees, 15 degrees, and 30 degrees were simulated for each subject by using a hard brace (G II Rehabilitation Brace). All the subjects performed walking trials on a flat floor about 10m at their preferred speed with or without contracture simulation (Fig. 1). Measurement was carried out at two different stages. First, level walking was measured without simulation, and then the same measurement was carried out with simulated flexion contracture at 0, 15 and 30 degrees of flexion in order. Same procedures were also carried out on the left side regardless of contracture simulation on the right.

Walking trials without brace were used as control. We evaluated walking velocity and trunk kinematics for each condition. In the coronal plane, the shoulder-pelvis bending angle (SPBA) was defined as the angle between the shoulder girdle line (right-left acromion line) and the pelvic (right-left anterior superior iliac spine) line (Fig. 2A-a,b) [1]. In the sagittal plane, the anterior inclination of the trunk was defined by the slope linked right acromion and right iliac crest, and the anterior inclination of the pelvis was defined by the slope linked right superior anterior iliac spine and right superior posterior iliac spine (Fig. 2B-c,d). Shoulder-pelvis rotation angle (SPRA) was defined as the angle between the shoulder girdle line and the pelvic line in the axial plane (Fig. 2C-e). Maximum values on right and left side were calculated respectively in SPBA and SPRA, and maximum values were also calculated in the sagittal plane. An analysis of variance (ANOVA) with a single factor was used to determine the difference in the statistical analysis. A p-value of < 0.05 was considered significant.

RESULTS
1. Walking velocity

Walking velocity was as follows; 1.19 ± 0.19 m/s at normal condition, 1.17 ± 0.19 m/s at 0 degrees, 1.12 ± 0.26 m/s at 15 degrees, and 0.98 ± 0.27 m/s at 30 degrees contracture. Walking velocity was significantly decreased at 30 degrees contracture. (P<0.01 between 0 and 30, P<0.05 between 15 and 30 degrees)

2. Changes of trunk kinematics (Fig. 3,4,5)

In the coronal plane, trunk tilted leftward rather than rightward at 30 degrees contracture, which indicated that the lumbar spine may bend convexly to knee contracture side rather than knee non-contracture side.

In the sagittal plane, trunk anterior inclination significantly increased at 30 degrees contracture. However, pelvic anterior inclination was not significantly different.

In the axial plane, right rotation was not notably different, but left rotation was significantly decreased at 30 degrees contracture.

DISCUSSION
Unilateral knee flexion contracture significantly influences trunk kinematics in each plane. In particular, the degree of lateral bending to the contracture side was significantly reduced, and this fact indicated that the lumbar spine may bend convexly to knee contracture side rather than knee non-contracture side. We also proved this phenomenon during relaxed standing in our previous study [2]. In the sagittal plane, simulated knee flexion contracture notably causes anterior inclination of trunk, which leads to decreasing lumbar lordosis. In addition, left rotation angle is less than right rotation angle in the axial plane. In conclusion, knee flexion contracture significantly influences physiological movements in trunk kinematics. These facts may result in “Knee-Spine Syndrome” [2] [3].

REFERENCES