INTRODUCTION
Severe knee osteoarthritis often causes knee flexion contracture, which limits patient’s activity of daily living. In addition, the other parts of the body compensate the contracture of the knee. Thus, knee flexion contracture leads to overload not only to other joints but also to the spine. Some previous studies showed the effect of knee flexion contracture to gait function by using gait analysis system [1] [2]. However, there was no study in which effect of the contracture to spinal alignment was evaluated by use of gait analysis system.

The purpose of the current study was to investigate the effect of knee flexion contracture on standing balance, and especially, to clarify the relationship between knee flexion contracture and spinal alignment.

METHODS
Fifteen 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. After informed consent, subjects were tested at the laboratory, using twelve retro-reflective markers, a five camera system (Pro-reflex, Qualysis) and a force plate (AM6110, Bertec). Unilateral (only right side limb) knee flexion contractures of 0 degrees, 15 degrees, and 30 degrees were simulated for each subject by putting a hard brace (O II Rehabilitation Brace) on. All the subjects stood in a relaxed state with placing one foot on a force plate (Fig. 1), regardless of contracture simulation. A reference point was determined in relaxed standing without simulated contracture. First, the following parameters were measured in right side at relaxed standing position without contracture simulation. In the coronal plane, trunk inclination angle was evaluated by estimating the slope that linked right acromion with left acromion, and pelvic inclination angle was evaluated by estimating the slope that linked right iliac crest with left iliac crest. Knee flexion angle and kinetics (knee resultant force: % body weight) was calculated by using an inverse dynamics technique. Knee flexion angle was also evaluated by use of goniometer, because simulation angle was confirmed before each measurement. Same measurements were performed in right side with flexion contracture simulation of 0, 15, and finally 30 degrees. And then, same measurements were done in left (non-contracture) side under each contracture condition in right side. 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. Changes from the reference point in the coronal plane (Fig. 2)
Left acromion gradually went down comparing with right acromion, as simulated contracture angle increased, and therefore, the trunk was tilted leftward. Right iliac spine went down as knee contracture got severe, and thereby, the pelvis was tilted rightward. (Positive value was obtained when right side was lower than left side.)

2. Changes from the reference point in the sagittal plane (Fig. 3)
In trunk inclination, no significant difference was detected. However, pelvic posterior inclination increased notably.

3. Knee kinetics (Fig. 4)
As the right knee got flexed, right knee resultant force gradually decreased. On the contrary, left knee resultant force increased, and thus, indicated that center of gravity shifted toward the unflexed side.

DISCUSSION
Unilateral knee flexion contracture influences standing balance not only in the sagittal plane, as the previous studies reported [3] [4], but also in the coronal plane. In the sagittal plane, knee flexion contracture causes posterior inclination of the pelvis, which may lead to decreasing lumbar lordosis.

In addition, the current study also shows the influence of knee flexion contracture in the coronal plane. When unilateral knee flexion contracture becomes severer, the amount of weight bearing increases in the contralateral knee. Also, ipsilateral pelvis and contralateral shoulder become lower than those under non contracture condition. Thus, it appears that spinal deformity exists in the coronal plane, for instance, the lumbar spine may bend convexly to the knee contracture side.

These facts may result in Knee-Spine Syndrome [3] [4].

REFERENCES