INTRODUCTION
Knee osteoarthritis (OA), which occurs symptomatically in approximately 11% of 65 years of age and older, account for more mobility disability in the elderly than other disease [1]. Although surgical treatment such as high tibial osteotomy and total knee replacement have been providing successful results for knee OA, there is a need to improve conservative treatment as cost-effective and non-invasive care for the patients.

A lateral wedged insole alters the mechanical alignment of the lower limb and reduces the loading in the medial compartment of the knee. Several studies have reported its effectiveness by clinically and biomechanically. Toda et al. [2] reported that the lateral wedged insoles with elastic strapping of the subtalar and ankle joint changed femorotibial angles and talar tilt angles in medial knee OA patients. They showed that the strapping insole had clinically better effects than the normal lateral wedged insole. However, the effects were shown under static condition and there has been no study that quantified dynamic biomechanical effect of the strapping insole.

The purpose of this study was to quantify the knee joint loads in medial compartment during gait using two types of lateral wedged insole (with and without ankle strapping) in medial knee OA patients. We hypothesized that the strapping insole reduces the dynamic loads in the medial compartment than the normal insole.

MATERIALS AND METHODS
Knee kinematics and kinetics were evaluated on 37 knees in 21 medial knee OA patients (19 women 2 men). The patients were 58 to 83 (mean 72) years old and had radiographic OA of at least grade 2 severity according to the Kellgren-Lawrence scale. Before the examination, Institutional Review Board for this study and informed consent were obtained for all subjects. The patients were tested at gait laboratory, using a four camera system (Pro-reflex, Qualysis) and a force plate (AM6610, Bertec) with 6 retro-reflective markers on the limb [3]. Knee mechanics was calculated using an inverse dynamics approach. The patients performed level walking at their comfortable walking speed. They were tested bare foot (without insoles), wearing lateral wedged insoles (normal insole; Fig.1A) and wearing lateral wedged insoles with elastic strapping of the subtalar and ankle joint changed (strapping insole; Fig.1B) on both sides. The order of testing of each condition was randomized. A silicon rubber of 10mm lateral wedge was used for two types of insoles. Peak knee adduction moment in stance phase and walking speed were evaluated by Wilcoxon signed-ranks test. Statistical significance level was set at p<0.05.

RESULTS
Peak knee adduction moment during walking without insole, with normal insole and with strapping insole were 4.2±1.7, 3.9±1.5, 3.7±1.4 (%BW*Ht) respectively and they were statistically different (Fig.2). The reductions in the peak knee adduction moment were larger with the strapping insole compared to the normal insole. The strapping insole reduced peak knee adduction moment by 13.1% compared to bare foot, and the normal insole reduced the moment by 8.0% compared to bare foot. Normal insole reduced the moment with all OA grades, on the other hand strapping insole reduced the moment only with grade 2 and 3 patients (Table 1).

Table 1. Peak knee adduction moment with each OA grade

<table>
<thead>
<tr>
<th>OA grade</th>
<th>N</th>
<th>Bare foot (%BW*Ht)</th>
<th>Normal insole (%BW*Ht)</th>
<th>Strapping insole (%BW*Ht)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>20</td>
<td>3.9±1.6</td>
<td>3.6±1.3</td>
<td>3.4±0.9</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>4.5±1.5</td>
<td>4.1±1.2</td>
<td>3.9±1.2</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>4.8±2.6</td>
<td>4.5±2.6</td>
<td>4.7±2.5</td>
</tr>
</tbody>
</table>

DISCUSSION
The results support our hypothesis that the lateral wedged insole significantly reduced the knee adduction moments during walking in patients with medial knee OA and suggest that strapping insole is more effective than normal insole for moderate graded OA patients. For grade 4, strapping insole had little effect to reduce the joint loads.

Valgus in talocalcaneal angle would be induced by both lateral wedged insoles. The varus deformity of the knee should not be changed by normal insole, because valgus inclination of the calcaneus occurs in the subtalar joint, and it should cancel the effect of the lateral wedge. Since the elastic strap would fix the subtalar and ankle joint, the strapping insole should cause valgus inclination of the talus and tibia, and result in effective correction of the varus alignment of the limb in patients with knee OA. As the varus deformity was corrected by strapping insoles and mechanical axis shifted laterally, they may effect to reduce the load in medial compartment of the knee. For grade 4 knees, the varus deformity should be so rigid that the strapping insoles were not able to correct the deformity.

As in the review [4], there is a strong scientific basis for applying wedge insoles in attempts to reduce OA pain of biomechanical origin and used for therapeutic method to knee OA. However, proper usage of this effective orthoses has not been well examined. Our study revealed that the strapping insoles had greater effect to reduce the joint load in the medial compartment of the knee for moderate OA deformity, but had little effect for severe deformity. It is recommended to use this type of insole as an effective and primary treatment for medial knee OA without severe deformity.

REFERENCES