GAIT ALTERATIONS IN PATIENTS WAITING FOR A TOTAL KNEE ARTHROPLASTY

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SUMMARY
The aim of this study was to quantify the mechanisms of compensation during gait in patients waiting for a total knee arthroplasty (TKA). The three-dimensional gait of twenty-six patients was compared with thirteen healthy elderly. Results show significant alterations in gait of patients compared with healthy subjects including the reduced sagittal knee motion, the lower knee extensor moment and the higher lateral trunk lean. This study 1) confirms the importance to consider both distal and proximal alterations in knee OA gait and 2) will improve the analyses of gait compensations changes following a TKA.

INTRODUCTION
It is well recognised that patients with knee osteoarthritis (OA) present important gait compensations [1-4]. Although most studies have focussed their researches on lower extremities compensations, recent studies have shown the importance of considering proximal gait compensations [3-4]. The aim of this study is to analyse the mechanisms of gait compensations in patients waiting for a TKA.

METHODS
Twenty-six patients with knee OA and scheduled for a TKA were included in this study. Exclusion criteria were knee, hip or ankle prosthesis, a recent history of lower limb or back surgery and neurological or orthopaedic disorders that could affect their gait or balance. Furthermore, patients were excluded if they could not walk for a short distance without the use of technical aids (e.g., cane). Thirteen subjects were recruited as control group. Control subjects were included if they were free from knee pain, had no recent history of lower limb or back surgery and had no neurological or orthopaedic disorders that could affect their gait or balance. Table 1 shows groups’ characteristics in terms of age, height, weight, body mass index (BMI) and gait speed.

A Vicon motion analysis system with 12 cameras (Mx3+) was used to measure three-dimensional (3D) gait biomechanics. Reflective markers were placed bilaterally using double-sided tape and following the standard Vicon Plug-in-Gait full body marker set. Ground reaction force data were measured using 2 force platforms (AMTI) embedded in the floor at the midpoint of a 10-meter walkway. The motion and force plate data were sampled at 100 Hz and 1000 Hz respectively.

The patients were asked to walk barefoot at their self-selected comfortable pace. Subjects included in the control group were asked to walk first at their comfortable speed and then at a slower pace. The speed that was closest to the averaged speed of the patients’ group was kept for further analysis.

Kinematics and kinetics data were filtered using the Woltring filtering function within Nexus software, version 1.4. Joint kinematics and kinetics were generated using the dynamic model (Vicon Plug-in-Gait). Joint moments were normalized for body weight (Nm/kg).

For each subject 5 gait cycles were used for kinetics analysis whereas a minimum of 10 gait cycles were used for kinematics. The peak value of the knee flexion angle, the peak value of the knee adduction/abduction moment during the mid-stance, the peak value of the knee flexor/extensor moment during the loading phase as well as the maximal trunk flexion/extension and the mean trunk lean in the frontal plane were analysed. Mean values for the variables listed above were obtained by averaging discrete values across the trials. The affected side of the patients’ group was compared with the right side of the control group. Results were compared between groups using ANOVA. When significant differences existed, Tukey post-hoc tests were conducted. A significant difference was set to \( P<0.05 \).

RESULTS AND DISCUSSION
Both groups were evaluated at a similar walking speed (1.1 ± 0.2 m/s vs 1.1 ± 0.2 m/s). Results show a significant reduction of the sagittal knee motion (46 ± 9° vs 55 ± 4°, \( P = 0.001 \)) of the knee extensor moment (0.23 ± 0.17 Nm/kg vs 0.38 ± 0.19 Nm/kg, \( P = 0.01 \)) and an increase of the lateral trunk lean (2 ± 1° vs 0 ± 2°, \( P = 0.0001 \)) in knee OA patients. Although slightly superior for knee OA patients, no significant difference (0.61 ± 0.17 Nm/kg vs 0.52 ± 0.14 Nm/kg, \( P = 0.1 \)) was observed for the knee adduction moment between groups (Figure 1).

The reduction of knee motion in patients waiting for a TKA induced both distal and proximal compensations during gait. The recognized quadriceps weakness in knee OA, essential...
during the loading response, might induce the reduction of knee extensor moment. The increase in trunk lean in the frontal plane as being compensatory for the reduction of pain will act to displace the center of mass laterally. This could explain the small differences between groups in knee adduction moment.

CONCLUSIONS
This study confirms the importance to consider both distal and proximal alterations in knee OA gait and will add new insight in further studies on the modification of gait compensations following TKA as well as a better understanding of gait abnormalities which is essential for optimal rehabilitation.

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REFERENCES

Figure 1. Ensemble average across the gait cycle (0-100%) for the trunk lean angle, the knee flexion/extension angle, the knee adduction/abduction moment and the knee flexor/extensor moment for each group. Dotted lines represent the knee OA patients and solid lines the control group subjects.

Table 1: Groups’ characteristics in terms of age, height, weight, body mass index (BMI) and gait speed. Significant difference between groups (P < 0.05) is marked with an *.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Age (years)</th>
<th>Height (m)</th>
<th>Weight * (kg)</th>
<th>BMI * (kg/m²)</th>
<th>Gait speed (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>68 ± 6</td>
<td>1.67 ± 0.10</td>
<td>81.8 ± 16.4</td>
<td>29.3 ± 5.3</td>
<td>1.1 ± 0.2</td>
</tr>
<tr>
<td>Control</td>
<td>66 ± 8</td>
<td>1.72 ± 0.11</td>
<td>70.5 ± 11.1</td>
<td>23.7 ± 2.7</td>
<td>1.1 ± 0.2</td>
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</tbody>
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