Knee pain in patients who have radiographic knee osteoarthritis is associated with spinal sagittal malalignment

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There are many patients who have severe radiographic knee osteoarthritis (OA) without pain. On the other hand, knee joints are influenced by spinal alignment to keep the standing and walking postures. It is still unknown how much the extent of the knee pain in the radiographic knee OA patients is associated with spinal alignment.

We investigated the relationship between the knee pain in the radiographic knee OA patients and sagittal spinal alignment using the data of volunteers aged over 50.
Method

We reviewed questionnaires and radiographs of **217 subjects** in musculoskeletal examination for the volunteers with age over 50. Utilizing the antero-posterior radiographs of the whole lower extremities in standing position, knee osteoarthritic grade (Kellgren-Lawrence grading system (KL grade)) and alignment of lower extremities (hip-knee-ankle angle (HKA)) were evaluated.

From these 217 subjects, **101 subjects** (31 males, 70 females and the average 76 years) with radiographic knee OA above KL grade 2 were selected for this study.
Evaluation items

1) Gender
2) Age
3) Body mass index (BMI)
4) Low back pain:
   Above 4/10 points by pain scale
5) Knee pain
6) Thoracic kyphosis (TK)
7) Lumbar lordosis (LL)
8) Sagittal vertical axis (SVA)
9) Pelvic tilt (PT)
10) Femoral inclination angle (FIA)
11) Hip-knee-ankle angle (HKA)

FIA: Angle between the plumb line and the line which connects femoral head center and midpoint of femoral shaft at 5cm distal from greater trochanter (average of bilateral femurs)
We divided the subjects into two groups (knee pain group (Group P: 60 subjects) and no knee pain group (Group N: 41 subjects)) by the respondent of questionnaires.

We compared the presence of low back pain and previously mentioned radiographic parameters between both groups.
## Results

<table>
<thead>
<tr>
<th></th>
<th>Group P</th>
<th>Group N</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male : Female</td>
<td>15 : 45</td>
<td>16 : 25</td>
<td>0.10</td>
</tr>
<tr>
<td>Age (years)</td>
<td>75.2 ± 6.1</td>
<td>77.2 ± 6.9</td>
<td>0.12</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>23.7 ± 2.8</td>
<td>22.1 ± 2.7</td>
<td>0.004*</td>
</tr>
<tr>
<td>Low back pain (number)</td>
<td>42 (70%)</td>
<td>15 (37%)</td>
<td>0.001*</td>
</tr>
<tr>
<td>TK (°)</td>
<td>31.0 ± 11.4</td>
<td>37.6 ± 17.4</td>
<td>0.02*</td>
</tr>
<tr>
<td>LL (°)</td>
<td>38.8 ± 14.3</td>
<td>40.5 ± 20.1</td>
<td>0.62</td>
</tr>
<tr>
<td>SVA (mm)</td>
<td>22.7 ± 34.6</td>
<td>34.7 ± 40.1</td>
<td>0.14</td>
</tr>
<tr>
<td>PT (°)</td>
<td>23.6 ± 9.0</td>
<td>22.9 ± 8.3</td>
<td>0.67</td>
</tr>
<tr>
<td>FIA (°)</td>
<td>9.7 ± 4.3</td>
<td>8.8 ± 4.2</td>
<td>0.33</td>
</tr>
<tr>
<td>HKA (°)</td>
<td>185.2 ± 4.0</td>
<td>184.4 ± 3.7</td>
<td>0.27</td>
</tr>
</tbody>
</table>
Results

Group P showed significantly higher low back pain and lower thoracic kyphosis ($p < 0.05$), suggesting that spinal malalignment and condition may associated with knee pain in the radiographic OA patients.

On the other hand, there were no significant relationship between knee pain and coronal alignment of the lower extremities.
First, when sagittal imbalance occurs, such as that with a spinal deformity, a backward pelvic tilt is the primary compensatory mechanism to maintain a standing position. However, when the hips reach their maximum extension with a more pronounced sagittal spinal imbalance, knee flexion compensates to enable a standing posture and leads to knee OA.

The second potential mechanism involves the strength of the paravertebral muscles; when the strength of these muscles decreases with knee OA, sagittal spinal imbalance occurs. Although a backward pelvic tilt compensates for the imbalance, the compensation is not effective, and an imbalanced spinal deformity (decreased lumbar lordosis and/or increased thoracic kyphosis) occurs.
<table>
<thead>
<tr>
<th></th>
<th>Kanemura: Average of the Japanese volunteers</th>
<th>This study: Average of the Japanese volunteers With knee pain</th>
<th>Previous study: Average of the Japanese knee OA patients before TKA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>44</td>
<td>75</td>
<td>73</td>
</tr>
<tr>
<td>TK (°)</td>
<td>40.2</td>
<td>31.0</td>
<td>47.1</td>
</tr>
<tr>
<td>LL (°)</td>
<td>53.6</td>
<td>38.8</td>
<td>48.8</td>
</tr>
<tr>
<td>SVA (mm)</td>
<td>-30.0</td>
<td>22.7</td>
<td>38.5</td>
</tr>
<tr>
<td>PT (°)</td>
<td>10.8</td>
<td>23.6</td>
<td>23.5</td>
</tr>
</tbody>
</table>

a) With the aging from 40 to 70 years, pelvis tilts posteriorly. And C7 plumb line is shifted anteriorly in patients with knee OA and knee contracture.

b) In knee OA patients with slight knee pain before operation, C7 plumb line is shifted posteriorly with decreasing thoracic kyphosis by the spinal flexibility.

C) Severe knee OA patients scheduled TKA can not keep the standing posture with upright trunk because of their knee pain and knee contracture. Consequently, the compensation is not effective, and an imbalanced spinal deformity (increased thoracic kyphosis and/or anterior shift of C7 plumb line) occurs.
Conclusions

We investigated the relationship between the knee pain in the radiographic knee OA patients and sagittal spinal alignment using the data of volunteers aged over 50.

In patients with radiographic knee OA, knee pain was associated with low back pain and lower thoracic kyphosis.


