The relationship articular cartilage degeneration and knee flexion angle.

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Introduction
It is generally thought that knee range decreases with increasing degenerative change of articular cartilage. However there are no reports about the relationship between articular cartilage degeneration and range of motion in the knee joint. The objective of this study was to identify the degree of articular cartilage degeneration due to osteoarthritis of the knee and to define the relationship between the degree of degeneration and flexion angle.

Methods
From August 2006 to February 2008, we performed 483 total knee arthroplasty procedures for 281 patients with osteoarthritis of the knee joint. 32 patients were men and 249 patients were women. The average age of these patients was 73.1 years (range 52-92). Preoperative average of extension angle was -7.0 (range -60° to 0°), and preoperative flex angle was 116.5° (range 50° to 150°).

We divided knee articular cartilage into eight sections as follows, ① patella, ② patella groove, ③ lateral femoral condyle, ④ medial femoral condyle, ⑤ lateral tibial condyle, ⑥ medial tibial condyle, ⑦ lateral posterior femoral condyle, ⑧ medial posterior femoral condyle (figure 1). Then, we observed articular cartilage degeneration of each section during the TKA operation. Articular cartilage degeneration was classified into four grades as follows, Grade 0 (Normal), Grade 1 (mild): minimal fibrillation, Grade 2 (moderate): overt fibrillation, partial cartilage erosion, Grade 3 (severe): extensive exposed subchondral bone, eburation of subchondral bone (figure 2).

We analyzed the relationship between the grading of articular cartilage and flexion angle using multiple regression analysis (stepwise) with knee flexion angle as the dependent variable and degenerative cartilage of each section as the explanatory variable.

Result
Articular cartilage degeneration grade of each section was as follows:
① patella: 9 knees in grade 0, 137 knees in grade 1, 247 knees in grade 2, 89 knees in grade 3, average grade was 1.87 (± 0.73), ② patella groove: 11 knees in grade 0, 100 knees in grade 1, 258 knees in grade 2, 114 knees in grade 3, average grade was 1.99 (± 0.73), ③ lateral femoral condyle: 69 knees in grade 0, 289 knees in grade 1, 82 knees in grade 2, 43 knees in grade 3, average grade was 1.21 (± 0.80), ④ medial femoral condyle: 0 knee in grade 0 and 17 knees in grade 2, 466 knees in grade 3, average grade was 2.96 (± 0.20), ⑤ lateral tibial condyle: 88 knees in grade 0, 310 knees in grade 1, 63 knees in grade 2, 20 knees in grade 3, average grade was 1.04 (± 0.70), ⑥ medial tibial condyle: 2 knees in grade 0, 6 knees in grade 1, 68 knees in grade 2, 405 knees in grade 3, average grade was 2.82 (± 0.84), ⑦ lateral posterior femoral condyle: 89 knees in grade 0, 283 knees in grade 1, 86 knees in grade 2, 25 knees in grade 3, average grade was 1.10 (± 0.75), ⑧ medial posterior femoral condyle: 3 knees in grade 0, 30 knees in grade 1, 144 knees in grade 2, 305 knees in grade 3, average grade was 2.55 (± 0.65) (figure 3).

Multiple regression showed patella articular cartilage and medial posterior femoral condyle have a significant difference (p<0.01). It also showed a relationship between degeneration change of patella articular cartilage and medial posterior femoral condyle and knee flexion angle.

Discussion
There are many cadaver reports indicating that patella groove articular or patellar articular have greater degenerative change than other parts. But our study showed the articular cartilage sections with the greatest degenerative change were the medial femoral condyle, medial tibial condyle and medial posterior femoral condyle. This is due mainly to the fact that patients in this study suffered from end stage osteoarthritis with varus leg. Our study showed greater degenerative change in the medial part of the knee.

Multiple regression analysis results showed that as degeneration of patella articular cartilage and medial posterior femoral condyle progresses knee flexion angle decreases. Therefore, knee flexion range was not limited only to medial section degenerative change. Patella or medial posterior condyle degeneration also causes limitation in knee flexion.

<table>
<thead>
<tr>
<th>Articular cartilage degeneration grade</th>
<th>Grade 0</th>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Grade 3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 0 (Normal)</td>
<td>9</td>
<td>137</td>
<td>247</td>
<td>89</td>
<td>482</td>
</tr>
<tr>
<td>Grade 1 (mild)</td>
<td>69</td>
<td>289</td>
<td>82</td>
<td>43</td>
<td>483</td>
</tr>
<tr>
<td>Grade 2 (moderate)</td>
<td>0</td>
<td>17</td>
<td>466</td>
<td>21</td>
<td>482</td>
</tr>
<tr>
<td>Grade 3 (severe)</td>
<td>88</td>
<td>310</td>
<td>63</td>
<td>26</td>
<td>483</td>
</tr>
</tbody>
</table>

Figure 1: We divided knee articular cartilage into eight sections undergoing TKA.

Figure 2: Articular cartilage degeneration was classified into four grades.

Figure 3: Progressive degenerative changes were numerous at medial femoral condyle, medial tibial condyle and medial posterior femoral condyle.