Change in the position of the popliteal artery with knee flexion after total knee arthroplasty

+ Takeda, M; Ishii, Y; Noguchi, H
+ Ishii Orthopaedic and Rehabilitation Clinic, Gyoda, Saitama, Japan
takeda724@hotmail.com

Introduction:
Total knee arthroplasty (TKA) is common orthopaedic operations with low complication rates. In the preoperative knee, 90° flexion allows the popliteal artery (PA) to move safely backward from the tibia [1]. However, this surgery is in close proximity to the PA, the behavior of which during flexion of the prosthetic knee is poorly understood. Especially, there is little appropriate information about the difference of the implant design in the literature.

We examined the position of the PA to assess the position of the vessel in knees after mobile-bearing TKA with posterior cruciate ligament (PCL)-retaining (PCLR) and PCL-sacrificing (PCLS) prostheses.

Materials and Methods:
A total of 22 patients (44 knees) were analyzed who underwent one side PCLR, and the other PCLS Low Contact Stress (LCS) prostheses (Depuy, Warsaw, Indiana). All patients were chosen from group with no clinical complication, and all had achieved passive full extension and at least 90° of flexion. Twenty-two age-matched knees served as controls. The clinical characteristics of the patients are summarized in Table 1.

We used a noninvasive technique with color-flow duplex scanning (e-Tool, EUB-7500; HITACHI Co.Ltd. JAPAN) to determine the distance X between the PA and the posterior margin of tibia (Figure 1). This distance X was measured initially with the knee in full extension, then repeated at 30, 45, 60, and 90 degrees.

Results:
The mean distance X was 8.2, 7.9, 7.8, 7.4, and 7.4 mm in PCLR knees and 8.5, 8.3, 7.9, and 7.7 mm in PCLS knees, respectively. No significant differences were found among the angles in each group or between the groups at each angle. In control knees, the mean distance X was 4.9, 5.2, 6.0, 6.2, and 7.8 mm, respectively (Figure 2).

This study indicated that the mean distance of both groups showed almost unchanged distance with knee flexion. Contrarily, the mean distance in controls, which was significantly greater at 90° than less than 45°, increased with progressive flexion.

Discussion:
Injury to the PA during TKA is a devastating complication. Although infrequent, theses injuries can result in the need for further surgery, including revascularization or possible even amputation [2].

Several authors identified the location of the PA using MRI, arteriography, and ultrasonography for osteoarthritis of the knee and cadaver knees [3][4]. Most authors concluded that the distance between the PA and the articular surface of the tibia increased with progressive flexion before arthroplasty [5]. However, there is little information about the comparison with PCLR and PCLS knees of the PA location in the literature.

In contrast to the control group, our results showed that the PA did not move posteriorly with flexion in either type of prosthetic knee. These results have a clinical significance, especially in revision surgery, in which the vessels may be more vulnerable to injury possibly as a result of thickened fibrotic tissues limiting the popliteal vessel motion.

In addition, our results showed that in 12 of 22 knees (55%) of the PCLR groups and in 15 of 22 knees (68%) of the PCLS groups, the popliteal artery was closer to the tibia in 90° of knee flexion than in full extension. These results suggested that 90° flexion is not always the safest position for PCLR or PCLS revision surgery. Therefore, we recommend to use color-flow duplex scanning to preoperatively evaluate flexion induced changes in position of the PA could help determine the optimal flexion angle during surgery to prevent PA injuries.

References:
1. Coventry MB et al. (1973) JBJS-Am.

Table 1. Patient characteristics.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>PCLR</th>
<th>PCLS</th>
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<tbody>
<tr>
<td>Knees/Patients</td>
<td>22/22</td>
<td>22/22</td>
</tr>
<tr>
<td>Gender (Male/Female)</td>
<td>7/15</td>
<td>7/15</td>
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<tr>
<td>Mean Flexion ± SD</td>
<td>119° ± 15°</td>
<td>119° ± 15°</td>
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<tr>
<td>HSS Score ± SD</td>
<td>92 ± 2</td>
<td>90 ± 4</td>
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<tr>
<td>Follow-up (month) ± SD</td>
<td>59 ± 28</td>
<td>64 ± 26</td>
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</tbody>
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* PCLR, posterior cruciate ligament-retaining prosthesis; PCLS, posterior cruciate ligament-sacrificing prosthesis; HSS, Hospital for Special Surgery

Figure 1. Ultrasound imaging

Figure 2. The relationship between distance X and knee flexion

mm

0° 30° 45° 60° 90°

PCLR PCLS controls

* PCLR, posterior cruciate ligament-retaining prosthesis; PCLS, posterior cruciate ligament-sacrificing prosthesis