POSTERIOR CRUCIATE LIGAMENT RETAINING MEDIAL-PIVOT KNEE

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PURPOSE
To analyze the clinical and radiographic results of patients who underwent total knee arthroplasty with a posterior cruciate retaining medial-pivot knee, and to identify the technical aspects in preserving the cruciate ligament.

MATERIALS AND METHODS
From March 2002 to Dec. 2003, 40 total knee arthroplasties with a cruciate retaining medial-pivot knee were implanted in 28 patients. The average follow-up period was 2.8 years (range, 2 to 3.7 years). The clinical and radiographic results were evaluated using the clinical and roentgenographic evaluation and scoring system of the American Knee Society.

RESULTS
The average flexion contracture before surgery was 5.4°, which improved to 0.6° at the last follow-up. The average preoperative knee flexation was 126.1° and 126.6° at the last follow-up. The average knee score improved from 60 points preoperatively to 94.8 points postoperatively, and the average functional score improved from 55.3 points to 87.0 points at the final evaluation. The average post operative α, β, r and a angles were 95.1°, 91.1°, 3.6° and 84°, respectively. There were no postoperative complications.

CONCLUSION
The short term clinical results in patients who had undergone total knee arthroplasty with a cruciate retaining medial-pivot knee was acceptable.

KEYWORDS
Knee, Posterior cruciate ligament, Arthroplasty, Medial-Pivot Knee

INTRODUCTION
Traditionally, the basic concept of the kinetics of the knee joint has been explained by the J-curve, femoral rollback and crossed four-bar link. Moreover, most of the prostheses that have been developed thus far were designed according to this concept. As a matter of fact, they showed relatively satisfactory results. However, many research findings that are contrary to these previous concepts have been reported lately. According to the findings of the research by Iwaki, et al, that used cadaver, medial femoral condyle showed only rotatory motion without movement in forward or backward direction during knee flexion and only lateral femoral condyle showed backward movement during knee flexion. Blaha et al reported that they also observed only rotational motion without femoral rollback in the medial side of knee joints of seven cadavers and they observed backward motion on the outside of the knee joint. The prosthesis designed by the new concept introduced under this backdrop is the medial-pivot knee.

Therefore, we intended to identify the surgical techniques that required retaining the posterior cruciate ligament and to analyze the clinical and radiological findings for cases in which the posterior cruciate ligament was retained among the cases where the knee joint arthroplasty was performed by using the medial-pivot knee.

MATERIALS AND METHODS
1. Subjects of Study
The subjects used for this study were 40 cases (28 patients) in which the posterior cruciate ligament was preserved among the cases for which the knee joint arthroplasty was performed by using the medial-pivot knee (ADVANCE® Medial-Pivot Knee System, Wright Medical Technology, Inc., Memphis, TN) from March 2002 to December 2003. All of the cases were females and their average age was 66.8 (54 to 77) at the time of surgery. As for the surgical location of the body, 18 cases had surgery on their right side and 22 cases had it on their left side and 12 patients had surgery on both sides. In terms of the diagnosis before the surgery, 37 cases had degenerative arthritis showing varus deformity of the knee joint and 3 cases had rheumatic arthritis. The follow-up period after surgery ranged from a minimum of 24 months to a maximum of 44 months, averaging 32.8 months.

2. Method of Study
For the clinical evaluation, we analyzed the knee scores and functional scores by using the clinical rating system of the American Knee Society before the surgery and during the final follow-up period, and measured the angle of flexion contracture of knee joint and maximum
flexion before the surgery and during the final follow-up period. For the radiological evaluation, we took the radiographs for the AP view and the lateral view while standing up before and after the surgery and during the final follow-up period, and evaluated the radiographs after the surgery by using the roentgenographic evaluation and scoring system of the American Knee Society. (Figure 1) We examined whether any complications had taken place after the surgery and during the follow-up period, and the statistical analysis was performed by using the SPSS version 11.5.

## 3. Surgical Technique

We used the medial parapatellar approach and general anesthesia for all of the cases. The prostheses used were the medial-pivot knee (ADVANCE® Medial-Pivot Knee System, Wright Medical Technology, Inc., Memphis, TN) and we used a posterior cruciate ligament retaining type. We implanted the femoral prostheses by increasing the external rotation a little more than 3 degrees to the posterior condyle axis and confirmed the ligament balance of the medial side and lateral side, and the balance between the flexion gap and extension gap by inserting the trial prostheses of the femoral and tibial inserts, and then bending and extending them. If the tension of the medial side ligament increased during bending, we performed the release of the posterior cruciate ligament slightly and if the tension increased more during flexion than extending, we achieved the proper ligament balance and the smooth motion of the prostheses by slightly increasing the release of the posterior cruciate ligament and the posterior slope. We used bone cement (Surgical Simplex™ P: Stryker® Howmedica, Allendale, New Jersey) for all of the patients when fixing the femoral prostheses and tibial prostheses, and we did not perform lateral retinacular release in all of the cases.

## RESULTS

In the analysis on the range of the knee motion, the flexion contracture had improved from an average of 5.4 (0 to 20) before the surgery to an average of 0.6 (0 to 5) during the final follow-up period, and the maximum flexion had changed from an average of 126.1 (90 to 135) before the surgery to 126.6 (100 to 140) during the final follow-up period. The knee score had improved from an average of 60.0 points (49 to 67 points) before the surgery to an average of 94.8 (92 to 100 points) during the final follow-up period.

### Table 1. The Angle of the Implant Position (Degrees)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>α</td>
<td>95.0±2.41</td>
<td>90-101</td>
</tr>
<tr>
<td>ß</td>
<td>91.0±1.95</td>
<td>87.4-95.7</td>
</tr>
<tr>
<td>r</td>
<td>03.6±2.81</td>
<td>-2.3-8.9</td>
</tr>
<tr>
<td>a</td>
<td>84.0±1.89</td>
<td>80.89</td>
</tr>
</tbody>
</table>

α, the femoral component angle in the frontal plane; ß, the tibial component angle in frontal plane; r, the femoral component angle in the sagital plane; a, the tibial component angle in the sagital plane.

The functional score had improved from an average of 55.3 points (45 to 65 points) before the surgery to an average of 87.0 (60 to 100 points) during the final follow-up period. In the radiological analysis after the surgery, the angle was 95.1 (90 to 101), the angle was 91.1 (87.4 to 95.7), the angle was 3.6 (-2.3 to 8.9), and the angle was 84.0 (80 to 89). (Table 1) No complications had occurred after the surgery and during the final follow-up period.

## DISCUSSION

We may have to consider many factors such as the design of the prostheses, the selection of an appropriate patient, the perfection of surgical techniques and the rehabilitation therapy after the surgery in order to obtain good results after the knee joint arthroplasty but the selection of the prostheses may be the most important factor among them. An ideal prosthesis is one that allows a fast and easy rehabilitation after the surgery, and it must be appropriate for the performance...
of daily routines, have a wider range of knee motions and stronger resistance to wear. It must also provide long life even to a young and active patient. In this sense, the understanding of the kinetics of normal knee joint may play a very important role in the development of an ideal prosthesis and surgical treatment using them. However, even though it is true that the prior prostheses had achieved substantial outcome in the relief of pain and the recovery of functions, most of the prostheses have failed in the revival of the kinetics and stability of the normal knee joint. The crossed four-bar link and femoral rollback, which were made known by Zuppinger and Strasser, and the J-curve concept announced by Gunston in 1971 have been recognized as the established theories for the past thirty years, and most of the knee joint prostheses developers have developed their prostheses based on these concepts. However, more and more studies have reported that femoral rollback has not actually occurred even with most of the posterior cruciate ligament retaining prostheses developed to induce such femoral rollback as well as the posterior cruciate ligament substituting type of prostheses. Actually, studies about the kinetics of the knee joint have been conducted for a long time. In 1985, Kurosawa et al reported that the medial femoral condyle didn’t move during the bending motion but only the lateral femoral condyle moved backward about 17mm, and in 1993, Hollister et al reported that the flexion motion of the knee joint was performed by one axis and the axis for the rotational motion of the knee joint was located in medial side. In 2000, Iwaki, et al reported that they could confirm the above opinions through six cases of cadaver experiments using magnetic resonance imaging tests.

The medial-pivot knee is a new prosthesis which has been developed under these concepts and it has a so-called ball-in-socket design which allows the rotational motion by the medial part because the joint surface between the femoral prosthesis and tibial prosthesis matches exactly and allows the rolling and gliding motions by the lateral part because the polyethylene joint surface of the tibial prosthesis is bigger than that of the femoral prosthesis. And the femoral prosthesis is made to have the same radius for the flexion of 0 degree to 90 degrees and the design of the patella increases the contact surface of the replaced patellofemoral joint since it has anatomically deeper trochlear groove with 3.6 degrees and is strong in subluxation because the lateral anterior flange is higher. This strength in design can minimize the wear of the polyethylene inserts because the area of contact surface between the medial tibiofemoral joint is much wider compared to the prostheses of other designs. It can avoid various problems that can occur due to the box cutting in the posterior cruciate ligament substituting type as the frontal part of the polyethylene insert has been designed to be higher by 11mm, and to improve the function of the patella since the diameters of trochlear grooves are the same. Actually, in 2003, Schmidt et al proved the rotational motion of the medial part by analyzing the joint movements of a patient for whom a knee joint arthroplasty was performed with the medial-pivot knee by using fluoroscopy. Minoda et al reported that as a result of the analysis of the synovial fluid of the patients who had undergone knee joint arthroplasty, the patient group who used the medial-pivot knees showed the formation of less wear particles. And in 2004, Pritchett reported that he surveyed 344 patients who had both knee joints arthroplasty with various prostheses about their preferences, and the result was that patients were more satisfied with the medial-pivot knees than with the posterior cruciate ligament retaining type prostheses or the posterior cruciate ligament substituting type of prostheses. Like these, the interest in the medial-pivot knee is growing and findings from experimental studies on them have been announced but there have been very few studies on the actual clinical results. Therefore, we have reported the clinical results of the medial-pivot knee.

There have been a few research reports on the range of joint motions among the patients who had undergone the knee joint arthroplasty with the medial-pivot knees. Anderson et al reported that the flexion angle increased from 109 degrees in the first year after the surgery to 120 degrees in the fifth year after the surgery, and Shakespeare et al reported that the average ROM of 111 degrees was possible in the first year after the surgery. Mont et al reported that the average ROM
was 113 degrees in six months after the surgery, 121 degrees in one year, and 123 degrees in two years, which were a little better results than those of Anderson and Shakespeare. The range of joint motion in this study was similar to that reported by Mont as it showed the average ROM of 126.6 degrees in 32.8 months after the surgery and the clinical results were also very good.

In 2004, the study performed by Gioe et al. with 5,760 cases of the knee joint arthroplasty reported that the knee joint revision arthroplasty was required in 2.9% of the cases, and the reason why we had revision is that 40.8% of the cases was caused by aseptic loosening and wear. The cases of the knee joint arthroplasty due to wear are gradually increasing and thus, many authors have been suggesting ways to reduce the wear. Schmidt et al. ascribed the wear of polyethylene inserts to the imperfect fit of the joint surface of the tibial prosthesis and the abnormal knee joint kinetics after the surgery. Therefore, it is natural to expect that the medial-pivot knee that is correcting these problems has greater resistance to wear.

In terms of surgical techniques, even though the medial-pivot knee is a new prosthesis which has different concepts and shapes from the previous prostheses, the previous tools and methods can be applied almost in the same way. For proper ligament balance and smooth motion of prostheses, we could obtain an appropriate tension of the posterior cruciate ligament and make flexion of the knee joint smooth by adjusting the release of the posterior cruciate ligament and the posterior slope as needed. And as the medial part of the polyethylene insert was designed to be higher than the lateral part, the medial side becomes more tense than the lateral side when the knee joint is flex after the insertion of the polyethylene insert, even though the knee joint flexion gap is made to be rectangular by adjusting the balance of the medial and lateral collateral sides well. In order to solve this problem, we maintained the balance between the lateral collateral ligament and medial collateral ligament when the knee joint was bent by inserting the femoral prosthesis with a little more external rotation than normal. (Figure 2)

CONCLUSION
The results of the short-term follow-up for the knee joint arthroplasty using the posterior cruciate ligament retaining medial-pivot knee were good. We may need to have much more experience and many long-term studies to be able to tell whether the prosthesis of such a new concept – the medial-pivot knee – will actually show good results in long-term follow-up studies.
BIBLIOGRAPHY

KOREAN ABSTRACT

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