Medial Unicompartmental Knee Arthroplasty in Patients with Spontaneous Osteonecrosis of the Knee

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Background: We analyzed the clinical and radiologic results of patients with spontaneous osteonecrosis of the knee treated by minimally invasive medial unicompartmental arthroplasty using Oxford Uni.

Methods: We reviewed 22 knees in 21 patients which were treated for spontaneous osteonecrosis between 2002 and 2006. Patients included one male and 20 females. The mean age was 70.8 years (range, 53 to 82 years). The mean follow-up period was 70.3 months (range, 48 to 93 months). The clinical results were evaluated using the Hospital for Special Surgery (HSS) knee score and the range of motion of the knee preoperatively and at the final follow-up. Preoperative plain radiographs and magnetic resonance images were analyzed to determine the size and stage of osteonecrotic lesions.

Results: The mean HSS knee score was 64.3 (range, 54 to 75) preoperatively and 92.0 (range, 71 to 100) at the final follow-up. The mean preoperative flexion contracture was 8.9° (range, 0 to 15°) and 0.2° (range, 0 to 5°) at the final follow-up. The mean further flexion increased from 138.6° (range, 100 to 145°) preoperatively to 145.6° (range, 140 to 150°) at the final follow-up. Active full flexion was possible within 2 months of the operation. The squatting position was possible in 16 patients (84.2%) out of 19, except one case of bronchiectasis and one case of spine fracture. The cross-leg posture was possible in 19 patients (90.5%) out of 21. The mean tibiofemoral angle was improved from varus 0.98° to valgus 3.22°. Meniscal bearing dislocation occurred in 2 cases and femoral component loosening occurred in 1 case.

Conclusions: Unicompartmental knee arthroplasty using Oxford Uni could be an alternative treatment option in spontaneous osteonecrosis of the knee.

Keywords: *Knee, Spontaneous osteonecrosis, Unicompartmental knee arthroplasty*

Spontaneous osteonecrosis of the knee (SPONK) was first reported by Ahlback et al.[1] in 1968. Since then, the terms SPONK and Ahlback's disease have been used synonymously.[1] The typical SPONK patient is fifty-five years of age or older, has no risk factors, has unilateral monoarticular pain, has limited involvement of the periarticular bone, and is involved mainly in medial femoral condyle.[2] The clinical presentation of SPONK commonly includes sudden onset of acute pain which is frequently worse at night.[2] The sudden acute onset of pain correlates with reports in the literature stating that insufficiency fractures with natural and expected surrounding necrosis of bone may be the underlying clinical pathology of this disorder. However, the exact pathogenesis is still unknown. The treatment options of SPONK are microfracture technique, high tibial osteotomy, unicompartmental knee arthroplasty, or total knee arthroplasty depending on the location, size, and progression of lesion, and on the patient's age and activity. In stages described as advanced by Mont clas-

sification which show a crescent sign in plain radiographs or magnetic resonance imaging (MRI), arthroplasty could be one of the best therapeutic options.[3-8] In stage 3 or 4 of SPONK in medial femoral condyle, unicompartmental knee arthroplasty is a treatment option and there are some authors who reported good clinical results using this minimally invasive technique.[9,10] However, a range of operative indications and clinical outcomes are controversial in various reports and the outcome of total knee arthroplasty is better than that of unicompartmental knee arthroplasty.[11,12]

We retrospectively analyzed the clinical and radiological results of unicompartmental knee arthroplasty in

Fig. 1. The condylar ratio is the ratio of the width of lesion (b) to the width of the medial femoral condyle (a) in anteroposterior radiographs. The condylar ratio = b/a × 100 (%).

SPONK localized in medial femoral condyle.

METHODS

Approval for the present study was obtained from the institutional review board. From June 2002 to March 2006, 21 patients of 22 knees were included without loss of follow-up. One patient was male and 20 patients were female. The mean age was 70.3 years (range, 53 to 82 years). The mean follow-up period was 70.3 months (range, 48 to 93 months). All unicompartmental knee arthroplasty using Oxford Uni (Biomet Ltd., Bridgend, UK) was performed by the senior author.

We measured the location, size, stage, condylar ratio, and the volume of the necrotic lesion via plain radiographs and MRI. The patients were over 50 years old, had non-specific past medical histories, had tenderness or pain confined to the medial side of the knee, and were stage 3 or 4 by Mont classification.[2] Other indications were intact anterior cruciate ligament (ACL) confirmed by MRI, varus deformity less than 15°, flexion contracture less than 15°, intact lateral compartment, and no translation via varus-valgus stress view. We excluded a patient who had both medial and lateral side lesions, painful arthritis in patellofemoral joint, and secondary osteonecrosis.

The stage of SPONK was evaluated by Mont classification.[2] In plain radiographs, stage 1 was normal appearance, stage 2 was existence of cystic and osteosclerotic lesions in distal femur or proximal tibia, stage 3 was existence of crescent sign and subchondral collapse, and stage 4 was narrowed joint space. The size of lesions was measured by condylar ratio, as described by Lotke et al.[13] Condylar ratio is the ratio of the width of lesion to the medial femoral condyle in anteroposterior radiograph (Fig.

Fig. 2. The volume of the lesion is measured with the magnetic resonance imaging as the product of the width and height in T1-weighted coronal images (A) and the depth in T1-weighted sagittal images (B).

1). The volume of lesions was product of the width (a) and height (b) in the T1-weighted coronal images and depth (c) in T1-weighted sagittal images from MRI (Fig. 2). The volume was then classified as small (0-10 cm^3), medium (10-20 cm^3), or large (20-30 cm^3).[2]

All patients were placed supine position after spinal anesthesia on a routine operating table with the lower leg rest bent downward. The thigh was fixed with a thigh holder with the hip flexed about 30° and the thigh tourniquet inflated. This placement of the leg permits passive knee flexion at least 120° during the procedure. Frequent flexion-extension manipulations are necessary during the procedure because some medial structures are preferentially visualized at either low or high degree of flexion.[14] Medial parapatellar incision was used and the patella was not everted. The average length was 6.3 cm (range, 6 to 6.5 cm). The average thickness of bearings was 3.7 mm (range, 3 to 5 mm). All bearings used in this study were non-anatomic bearings, which were non-specific and usable on either side. From the first day after surgery passive range of motion was started. The maximum passive flexion was performed from about postoperative 7 days until discharge.

The clinical results were evaluated using the range of knee motion and Hospital for Special Surgery (HSS) knee score, preoperatively and at the final follow-up. We also checked squatting and cross leg sitting postures which are common in Korean daily life. In radiologic assessments, weight-bearing anteroposterior and lateral radiographs of the knee and hip to ankle films for measuring tibiofemoral angle were taken at each visit. Mechanical failures, such as component loosening or rotation, and component migration or subsidence were also checked. Either tibial or femoral components were considered loosening when radiolucency was greater than 2 mm around the components. Component rotation was considered when greater than 10°.[15,16] The end point for survival was defined as revision for any reason. The 95% confidence intervals were calculated using the method of Kaplan-Meier. All collected data were analyzed statistically using SPSS ver.18.0 (SPSS Inc., Chicago, IL, USA). For all tests, a p-value less than 0.05 was considered significant. To improve the inter-observer reliability of each measurement, the measurements of two major orthopedic specialists and one resident were averaged (intra-class coefficient, 0.961).

RESULTS

The SPONK lesion was limited to the medial condyle of the distal femur in all cases. The lesions were all stage 4 in Mont classification. Sixteen knees (72.7%) were lower that 40% of condylar ratio and 6 knees (27.3%) were higher than 40% of condylar ratio. The volume of lesion was small in 17 cases (77.3%), medium in 2 cases (9.1%), and large in 3 cases (13.6%) (Table 1).

In all patients, passive full flexion of the knee was possible within 7 days of the operation and painless active full flexion was possible 2 months after the operation. The mean HSS score increased from 64.3 (range, 54 to 75) to 92.0 (range, 71 to 100) at the time of the final follow-up ($p < 0.05$). The mean preoperative flexion contracture was 8.9^o (range, 0 to 15), which improved to mean 0.2^o (range, 0 to 5) at the final follow-up. The mean preoperative full flexion was 138.6^o (range, 100 to 145°), which improved to mean 145.6^o (range, 140 to 150°) at the final follow-up ($p < 0.05$). The mean preoperative tibiofemoral angle was varus 0.98^o and was corrected to mean valgus 3.22^o. Thus, the mean correction degree was 4.2^o. The squatting position was possible in 16 patients (84.2%) out of 19, except one case of bronchiectasis and one case of spine fracture. The one case of bronchiectasis could not be checked for squatting due to the intolerable medical condition at the final follow-up. The other case of spine fracture could not be checked for squatting because of severe back pain. The cross-leg posture was possible in 19 patients (90.5%) out of 21.

Complications occurred in 3 knees of 3 patients (13.6%). Bearing dislocations occurred in 2 cases (9.1%) (Table 1). They returned to the pre-dislocation level of activity with the insertion of thicker bearing. Beneath the tibial components, either complete or partial radiolucent lines were seen in 15 knees out of 22. However, the formation of radiolucent lines was not related with tibial component loosening. Femoral component loosening occurred in one case (4.5%). This case had a preoperative lesion of 49.3% in condylar ratio and was large in volume (22.8 cm^3). It was converted to revision total knee arthroplasty. The survival rate at 6-years was 78%, with revision for any reason as the end point (95% confidence interval) (Fig. 3).

DISCUSSION

Numerous reports have been published on clinical and radiological outcomes of unicompartmental knee arthroplasty for treatment of osteoarthritis, while only limited data are available for SPONK. Fewer studies on SPONK indicate that the incidence is less frequent. This study is confined to patients who had SPONK limited to the medial condyle of the distal femur.

There are several treatment options for managing

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Table 1. Details of Patient Data

No.	Age/sex	Follow-up period (mo)	Condylar ratio (%)	Volume of necrotic lesion (cm^3)	Complication
1	70/M	93	49.3	Large (27.2)	Femoral loosening
2	76/F	93	52.1	Small (6.4)	-
3	76/F	92	32.7	Small (7.3)	Bearing dislocation
4	77/F	88	35.5	Small (7.5)	-
5	66/F	96	28.4	Small (5.4)	-
6	73/F	85	37.6	Small (8.2)	-
7	67/F	76	33.9	Small (4.8)	-
8	67/F	73	36.3	Small (8.2)	-
9	77/F	72	30.2	Small (9.6)	Bearing dislocation
10	71/F	69	39.1	Medium (14.7)	-
11	68/F	68	23.7	Small (6.4)	-
		68	47.6	Small (6.2)	-
12	72/F	67	25.0	Small (7.3)	-
13	76/F	65	33.0	Small (4.3)	-
14	61/F	65	55.0	Small (5.8)	-
15	75/F	64	32.0	Large (21.5)	-
16	82/F	61	38.0	Small (4.9)	-
17	74/F	56	53.0	Medium (16.7)	-
18	53/F	54	30.0	Small (8.6)	-
19	71/F	52	47.0	Large (26.3)	-
20	74/F	52	37.0	Small (8.8)	-
21	61/F	48	32.0	Small (8.2)	-
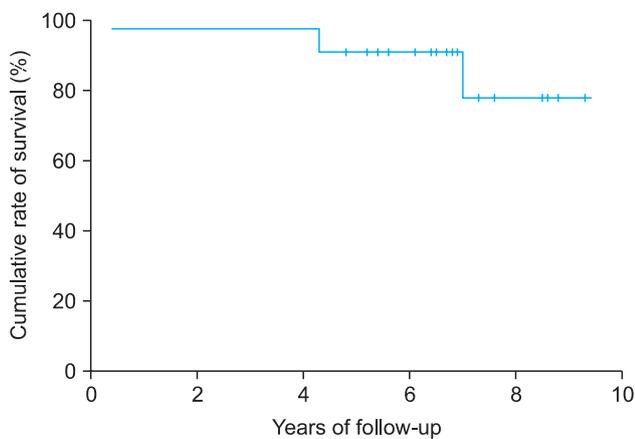
Fig. 3. Cumulative rate of survival of the prosthesis was 78% 6 years after operation (95% confidence interval).

SPONK, including high tibial osteotomy, debridement, and autologous bone graft. If other treatments failed or if the stage of SPONK was 3 or higher, the treatment of choice is arthroplasty.[4] Arthoplasties of the knee can be either total or unicompartmental. Reports have shown variable results of each method.[11,12,17] Marmor[6] obtained good clinical results from 30 cases in 34 patients who had unicompartmental knee arthroplasty. However, two patients got revision arthroplasty due to depression around where they had surgery and two patients got revision arthroplasty due to newly forming lesions in the lateral condyle of the femur. Radke et al.[12] reviewed 39 cases. Among them, 23 were unicompartmental knee arthroplasty and 16 were total knee arthroplasty. With and average follow-up of more than 5 years, they reported the patients who underwent total knee arthroplasty showed clinically bet-

ter results. In patients who underwent unicompartmental knee arthroplasty, four had a revision arthroplasty. However, they reported that the main causes of the poor results of the unicompartmental knee arthroplasty are inadequate operative technique and patient selection. Recently, good clinical results and high long-term survival rates of unicompartmental knee arthroplasty have been reported due to improvement of surgical technique, component design, and strict selection criteria.[11,18] Therefore, we applied narrow and strict indications for the patient selection.

Soucacos et al.[19] suggested that patients of stages 1 and 2 be treated by conservative management and of stages 3 and 4 be treated with surgery according to the size of the lesion. Lotke et al.[13] suggested that surgical treatment should be considered when femoral condyle rate is over 50%. Aglietti et al.[20] suggested that prognosis is poor when femoral condyle rate is over 40% and the lesion is over 5 cm^2. Consequently, most studies state that progression period and lesion size of SPONK are the most important factors.[5,13,19,20] The stage of lesion was classified as 4 or 5 using plain radiographs by many authors[5,20-22] and there were several methods to measure the size of lesions. Most authors[16,20,23] use anteroposterior plain radiograph for measuring the condylar ratio and lateral plain radiograph for measuring the extent of lesion that can be utilized in therapeutic methods and decisions of prognosis. However, Bjorkengren et al.[24] recommend that MRI is needed for early diagnosis of spontaneous osteonecrosis because it can determine more about the range of involved bone marrow and damage of cartilage by collapsed bone compared with plain radiographs. They reported the utility of MRI to obtain more information about stage and prognosis in SPONK. Lotke and Ecker[25] reported that the determination of the stage of lesion was more precise in MRI than in plain radiographs. We experienced a few cases that were difficult to measure because the lesions were superimposed on the lateral condyle of the femur in lateral plain radiograph. MRI was taken in all cases before surgery and we classified the lesions into 3 groups according to the volume of lesion.

Complications occurred in 3 cases (13.6%) in our study. We experienced one case of femoral loosening. The volume of this case was 22.8 cm^3 and was classified as large. The lesion extended to the diaphysis and to the epiphysis. Two cases of bearing dislocation occurred which all were changed to thicker bearing. The exact mechanism of bearing dislocation is still unclear. Lewold et al.[26] documented that bearing dislocation attributed to malposition of the components and soft tissue imbalance with subsequent maltracking of the meniscal bearing. Another probable mechanism is posterior impingement by remaining meniscus or osteophytes, ligament laxity due to release of medial collateral ligament, or physiologic laxity of lateral collateral ligament.[27] It was assumed that different life styles common in Korea, such as full flexion, squatting, and sitting on the floor, might cause strain of anterior cruciate ligament, which might be a causative factor of bearing dislocation. Care must be taken for preventing bearing dislocation.

Even though we applied strict indications for patient selection, the survival rate at 6-years of 78% (95% confidence interval) was not very high in this study. We thought that it was due to the fact that we could not establish guidelines for total or partial knee replacement. We were also not able to explain the exact mechanism of bearing dislocation or loosening of femoral component. The limitations of our study were that we retrospectively analyzed the clinical and radiological results of unicompartmental knee arthroplasty in SPONK without a control group of total knee arthroplasty. In addition, the sample size of our study was small.

In conclusion, minimal invasive unicompartmental knee arthroplasty using Oxford Uni could be an alternative treatment option in spontaneous osteonecrosis of the knee.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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