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Original Article

Postoperative clinical outcomes of unicompartmental knee arthroplasty in patients with isolated medial compartmental osteoarthritis following medial meniscus posterior root tear

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ABSTRACT

Background: Cartilage degradation progresses rapidly following medial meniscus posterior root tear (MMPRT). Unicompartmental knee arthroplasty (UKA) has been performed for medial compartmental osteoarthritis following MMPRT. We evaluated the clinical and radiographic outcomes of UKA for medial compartmental osteoarthritis after an untreated MMPRT.

Methods: Twenty-one patients who underwent UKA for isolated medial compartment osteoarthritis following MMPRT were retrospectively investigated. Clinical outcomes were assessed using the Knee Injury and Osteoarthritis Outcome Score and knee range of motion. The posterior tibial slope and tibial component inclination were evaluated using plain radiographs.

Results: The mean follow-up periods were 25.5 ± 13.8 months. Clinical outcomes improved significantly postoperatively. The mean postoperative knee extension angle was $-1.1^\circ \pm 2.1^\circ$, and the knee flexion angle was $134.3^\circ \pm 4.9^\circ$. The posterior tibial slope angle decreased from $9.0^\circ \pm 2.0^\circ$ preoperatively to $5.4^\circ \pm 1.8^\circ$ postoperatively, and postoperative tibial component inclination at the final follow-up was $2.9^\circ \pm 1.1^\circ$ varus. No aseptic loosening or deep infections were observed.

Conclusion: UKA significantly improved clinical outcomes and could be a viable surgical option for treating isolated medial compartmental osteoarthritis accompanied by untreated MMPRT.

1. Introduction

The medial meniscus (MM) posterior root functions as an anchor for regulating meniscal movement during knee flexion or load-bearing. Pathologically, an MM posterior root tear (MMPRT) can accelerate the degeneration of the articular cartilage in the knee joint by disrupting meniscal functions. MMPRT can suddenly deteriorate the articular cartilage and subchondral bone by rapidly altering knee joint kinematics and homeostasis.[1] Recently, several techniques for repairing MMPRT have been developed and the pullout repair of MMPRT is considered to be the gold standard. Favourable clinical outcomes have been reported in patients with MMPRT treated by transtibial pullout repair if the medial cartilage remained.[2,3]

If MMPRT remains untreated, the degeneration worsens and sometimes causes subchondral insufficiency fractures of the knee (SIFK) or severe osteoarthritis (OA).[4] Operative indications for the pullout repair of MMPRT might be limited as the knee symptoms caused by loss of cartilage or subchondral lesions may not improve.[5] Non-operative treatments of MMPRTs have been associated with poor clinical outcomes, worsening knee OA, and approximately 30 % of all total knee arthroplasties (TKAs) at a mean period of 30 months after MMPRT diagnosis.[6] However, few studies

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have reported the clinical outcomes of arthroplasty when used to treat secondary OA after untreated MMPRT.[7]

Unicompartmental knee arthroplasty (UKA) was performed at our institute for isolated medial compartmental OA, following untreated MMPRT that did not meet the operative indication for transtibial pullout repair. This study aimed to evaluate the clinical and radiographic outcomes of UKA for medial compartmental OA following untreated MMPRT.

2. Patients and methods

2.1. Study design and population

This study was approved by the ethics committee of the authors' affiliated institution (approval no. 1857), and written informed consent was obtained from all included patients. This study was conducted according to the principles of the Declaration of Helsinki. Patients admitted to our institution between April 2014 and June 2019 were screened for MMPRT. A total of 248 patients diagnosed with MMPRT according to characteristic magnetic resonance imaging (MRI) findings were screened. Patients who underwent UKA for isolated medial compartmental OA (≥Kellgren and Lawrence [K-L] grade 2) and could be followed up for at least 1 year were enrolled. Indications for the transtibial pullout repair of MMPRTs were set as follows: a femorotibial angle ≤180°, a radiographic K-L grade ranging from 0 to 2 (with or without low-grade SIFK[8]), and a body mass index <35 kg/m^2 (Fig. 1). Indications for UKA were set as follows: a radiographic diagnosis of isolated medial compartmental OA with a K-L grade ranging from 2 (with high-grade SIFK[8]) to 4, a fixed flexion deformity <10°, and an active range of motion (ROM) ≥90° (Fig. 1). Patients with missing data (n = 17), those for whom pullout repair was performed (n = 179), and those who underwent conservative treatment (n = 31) were excluded. Overall, 21 patients who underwent UKA were included and retrospectively investigated. The time of injury was set as the time of painful popping episodes.

2.2. Surgical procedures

2.2.1. UKA

UKA was performed using the medial Zimmer Persona Partial Knee System (Zimmer Inc, Warsaw, IN, USA) by two senior doctors, each with ≥10 years of experience in performing knee arthroplasty. A midvastus approach was employed with an incision from the superomedial border of the patella to 3 cm distal to the medial tibia plateau articular surface. The medial soft tissue was minimally released to retain knee alignment, and medial compartment osteophytes were removed. A proximal tibial resection was performed using the extramedullary alignment guide; the sagittal cut slot was positioned in a way the resection plane is adjacent to the medial fibres of the anterior cruciate ligament attachment, and the slot passes directly medial to the apex of the medial tibial spine. Moreover, the proximal tibial resection angle was set at 0°–3° varus from the mechanical axis in the coronal plane and 5°–7° from the posterior tibial slope (PTS) in the sagittal plane of the tibia.[9] Following proximal tibial resection, a distal femoral condyle resection was performed with the knee in extension, inserting a cutting guide. After the flexion/extension gap was determined, appropriate femoral sizing was performed, and the remaining femur osteotomies were performed.

2.3. Clinical evaluations

Routine postoperative follow-up visits were scheduled at 6 months, 1 year, and every year thereafter. Clinical data comprising the Japanese Knee Injury and Osteoarthritis Outcome Score (KOOS), International Knee Documentation Committee subjective knee evaluation form, and pain visual analog scale (VAS) were collected. KOOS consists of five subscales: pain, symptoms, activities of daily living, sport and recreation function, and knee-related quality of life. Pain intensity in the knee was assessed using a 100-mm VAS, ranging from 0 mm (no pain) to 100 mm (worst possible pain). ROM was determined using a goniometer; we assessed maximum knee flexion (°) and determined the presence of extension deficiencies (°).

2.4. Radiographic evaluation

Radiographs at the final follow-up after UKA were analysed and compared with the preoperative conditions of all patients retrospectively. The postoperative tibial component alignment was analysed on conventional radiographs in two planes as described previously.[10] The PTS angle was defined as the angle between the line perpendicular to the proximal tibial longitudinal axis and the medial tibial plateau (angle X) or the tibial component undersurface (angle Y) in the sagittal plane on lateral radiographs (Fig. 2A and B). Tibial component inclination (TCI, angle Z) was assessed on a long-leg standing view on an anteroposterior radiographs and was defined as the angle between the tibial component undersurface and the line perpendicular to the anatomical tibial axis (Fig. 2C).

2.5. Statistical analysis

Statistical analyses were performed using EZR software (Saitama Medical Center, Jichi Medical University, Tochigi, Japan). Data are expressed as mean ± standard deviation unless otherwise indicated. Statistical significance was set at $p < 0.05$. The paired *t*-test was used to compare preoperative and postoperative radiographic values or clinical outcomes. Inter-observer reproducibility and intra-observer reliabilities were assessed with the intra-class correlation coefficient (ICC). An ICC >0.83 was considered as a reliable measurement. To determine inter-observer reproducibility, all radiographs were reviewed by two experienced orthopaedic surgeons, and PTS and TCI values were investigated. One of the researchers reviewed the radiographs twice on two different occasions to calculate the intra-observer repeatability. The inter-observer reproducibility and intra-observer repeatability of the PTS and TCI measurements were considered satisfactory when mean ICC values were 0.83, 0.85, 0.84, and 0.85, respectively, for PTS and TCI measurements.

3. Results

Patient demographics and clinical characteristics are shown in Table 1. The mean follow-up period was 25.5 ± 13.8 months (range, 12–54 months). The mean age of patients at the time of operation was 69.5 ± 6.6 years. The mean time from injury to MRI was 195.2 ± 200.4 days. SIFK was observed in 7 knees, and medial compartmental OA was observed in 14 knees on preoperative radiographic examination. A significant improvement in clinical outcomes was noted postoperatively (Table 2). At the final follow-up, knee extension was −1.1° ± 2.1° and knee flexion was 134.3° ± 4.9°. Radiographic outcomes are presented in Table 3. For radiographic assessment, no significant difference was observed between preoperative and postoperative femorotibial angles (178.4° ± 1.8°, 177.8° ± 1.4°). The PTS angle decreased postoperatively (from 9.0° ± 2.0° preoperatively to 5.4° ± 1.8° postoperatively). The TCI angle at the final follow-up was 2.9° ± 1.1°. No aseptic loosening or deep infections were observed during follow-up.

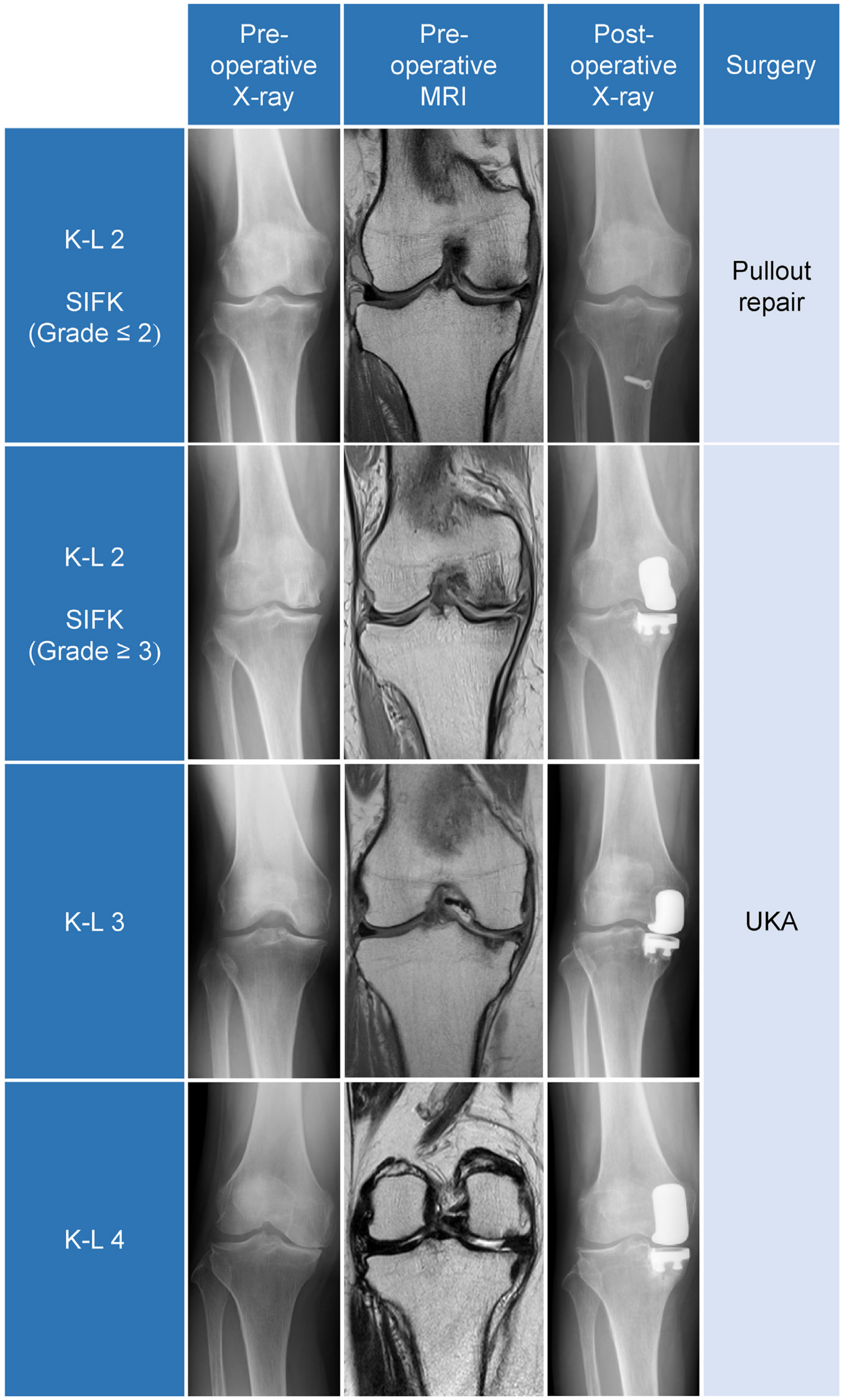

Fig. 1. Indication of the surgical treatment for medial compartmental osteoarthritis following medial meniscus posterior root tear.
The radiographic indication for transtibial pullout repair was a Kellgren and Lawrence (K–L) grade 0 to 2 (with or without low-grade subchondral insufficiency fractures of the knee [SIFK]). The radiographic indication for unicompartmental knee arthroplasty was a K-L grade 2 (with high-grade SIFK) to 4.

4. Discussion

The most important finding of this study was that favourable clinical outcomes were obtained using UKA to treat isolated medial compartmental OA following MMPRT. Feucht et al. reported that they performed the transtibial pullout repair of the MMPRT if the remaining cartilage is present in the medial compartment.[11] Additionally, favourable clinical outcomes have been reported

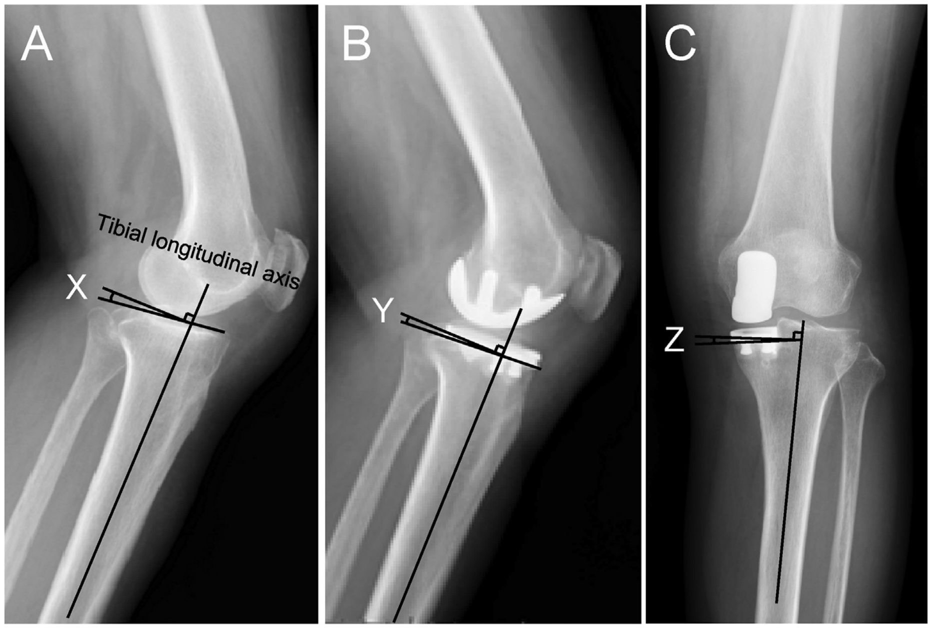

Fig. 2. Radiographic measurements.
a. Angle X was defined as the angle between the line perpendicular to the proximal tibial longitudinal axis and the medial tibial plateau on lateral radiographs.
b. Angle Y was defined as the angle between the line perpendicular to the proximal tibial longitudinal axis and the tibial component undersurface on lateral radiographs.
c. Angle Z was defined as the line perpendicular to the anatomical tibial axis and the angle between the tibial component undersurface in a long-leg standing view.

Table 1
Patient demographics and clinical characteristics.

Characteristic	Values
Number (knees)	21
Gender (male/female)	4/17
Age (years)	69.5 ± 6.6
Height (m)	1.55 ± 0.1
Weight (kg)	58.9 ± 11.0
Body mass index (kg/m^2)	24.5 ± 3.6
Duration from injury to MRI (day)	195.2 ± 200.4
Duration from injury to operation (day)	236.9 ± 207.3
Root tear classification (Type 1/2/3/4/5)	0/18/0/3/0
Preoperative K-L grades (0/1/2/3/4)	0/0/5/15/1

Values are presented as mean ± standard deviation or number. Kellgren and Lawrence, K-L; magnetic resonance imaging, MRI.

Table 2
Preoperative and postoperative clinical scores.

Clinical scores	Preoperative	Postoperative	P value
KOOS-Pain	53.7 ± 22.4	84.7 ± 12.3	<0.05*
KOOS-Symptoms	54.6 ± 20.1	84.9 ± 11.7	<0.05*
KOOS-ADL	64.9 ± 13.6	87.6 ± 9.1	<0.05*
KOOS-Sport/Rec	28.9 ± 30.9	54.5 ± 20.6	<0.05*
KOOS-QOL	27.0 ± 7.4	61.5 ± 22.4	<0.05*
IKDC score	32.4 ± 23.6	64.2 ± 11.9	<0.05*
Pain score (VAS)	38.6 ± 27.6	9.2 ± 9.1	<0.05*

Values are presented as mean ± standard deviation. Knee Injury and Osteoarthritis Outcome Score, KOOS. Activities of daily living, ADL. Sport and recreation function, Sport/Rec. Knee-related quality of life, QOL. International Knee Documentation Committee, IKDC. Visual analog scale, VAS. * Statistically significant ($P < 0.05$).

previously following MMPRT treatment.[2,3,12] However, if MMPRT remains untreated, rapid degeneration occurs, resulting in medial compartmental OA or SIFK, which are consequences of insufficiency fractures combined with the necrosis of the surrounding bone.[13,14] The time from injury to surgery was longer (195 days) in this study than that reported in studies reporting MMPRT treatment using transtibial pullout repair (80–99 days); thus, relatively severe chondral damage was observed.[2,15,16] It is difficult to treat MMPRT using transtibial pullout repair if the cartilage is severely damaged because knee symptoms caused by chondral or subchondral lesions, such as knee pain at night or on weight-bearing, might not be relieved.[5,13,14,17] Therefore, UKA could be a beneficial option to treat isolated medial compartmental OA following untreated MMPRT that could not be treated using pullout repair. Furthermore, although UKA is generally performed for bone-on-bone medial OA due to its inferior outcome on patients without bone-on-bone arthritis, it could be a reliable option for the treatment of less radiographic OA after MMPRT.[18,19]

In a previous meta-analysis of retrospective observational studies, cemented UKA showed similar survival and clinical outcomes in patients with both SIFK and medial compartmental OA.[5] In contrast, a comparative study found worse clinical and survival outcomes of UKA compared to those of TKA in patients with SIFK; this might have been due to the poor bone quality of the bone in which a SIFK lesion occurred. Furthermore, poor bone quality may affect implant fixation.[20] In the current study, although no tibial component loosening was observed, and clinical outcomes were comparable to other reports using other prostheses, attention should be given to implant failure, especially in knees with SIFK.[21,22]

PTS is known to be one of the main factors affecting postoperative TKA outcomes.[23,24] The role of PTS has been discussed in the recent literature in the context of UKA; however, its role is not completely understood.[25] An excessive slope is known to result in an active anterior tibial translation, which increases the load on the anterior cruciate ligament and favours the subsequent distension of the ligament, resulting in knee instability.[9] Moreover, Hernigou and Deschamps suggested that a PTS of a tibial implant >7° should be avoided to preserve the longevity of the implant because increasing PTS may cause anteroposterior instability.[9] In contrast, steep PTS was a risk factor for MMPRT development, and preoperative PTS in knees that underwent arthroplasty was higher than in normal

Table 3
Radiographic measurements.

Radiographic measurements	Preoperative	Postoperative	P value
Femorotibial angle (°)	178.4 ± 1.8	177.8 ± 1.4	n.s.
Posterior slope angle of tibial component (°)	9.0 ± 2.0	5.4 ± 1.8	n.s.
Tibial component inclination (°)		2.9 ± 1.1	

Values are presented as mean ± standard deviation. Not significant, n.s.

knees, with a mean value of 9.0°.[26,27] If the tibial slope is cut by the native posterior slope, anteroposterior instability might occur, resulting in early failure. Alternatively, if the tibial slope decreases, the component gap during flexion becomes tight relative to that during extension.[25] Thus, the optimal proximal tibial resection angle would be 5°–7°, and the excessive reduction of PTS should be avoided. In this study, it was found that posterior tibial resection could be conducted within the optimal PTS range (Fig. 3). TCI is another issue that affects the restoration of joint kinematics and bone resistance to loading.[28,29] Chatellard et al. stated that a change exceeding 3° in TCI could lead to decreased prosthesis survival.[28] The mean TCI value observed in this study was almost parallel to that of the joint line because physiological obliquity of the femorotibial joint space is about 3° varus.

Despite the novelty of our findings, this study had several limitations. First, the postoperative follow-up period was too short and did not allow for an appropriate evaluation of the long-term clinical outcomes of UKA. Second, this report is a case series, not a comparative study, and the sample size was small. Third, the validity of operative indications used in this study remains unknown. Further comparative clinical studies between surgical options according to the severity of OA following MMPRT are needed to find better treatments. Fourth, the presence of the medial compartmental OA at the time of injury was unclear. However, considering the longer duration from injury to surgery (237 days on average), the degenerative change progressed rapidly after MMPRT, and medial compartmental OA was present at the timing of surgery.[4,6] Finally, although clinical and radiographic outcomes were assessed, we did not compare UKA and other treatments, such as transtibial pullout repair, high tibial osteotomy, or TKA.

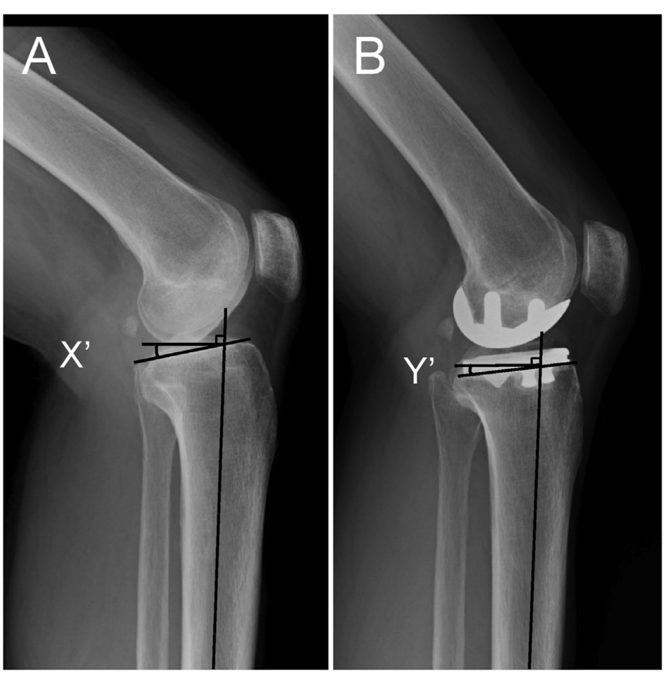

Fig. 3. Posterior tibial slope (PTS) measurement in the sagittal plane on lateral radiographs.
a. Angle X′ was 13° before unicompartmental knee arthroplasty (UKA).
b. Angle Y′ was 7° after UKA, which was within the optimal PTS range.

5. Conclusions

UKA improved postoperative clinical outcomes without early radiographic failure. UKA could be a viable surgical option to treat isolated medial compartmental OA combined with an untreated MMPRT.

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Declaration of interests

The authors have no conflicts of interest to declare relevant to this article.

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