The clinical outcome of revision knee replacement after unicompartmental knee arthroplasty versus primary total knee arthroplasty: 8–17 years follow-up study of 49 patients

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Abstract When unicompartmental knee arthroplasty (UKA) failure occurs, a revision procedure to total knee arthroplasty (TKA) is often necessary. We compared the long-term results of this procedure to primary TKA and evaluated whether they are clinically comparable. Twenty-one patients underwent UKA conversion to TKA between 1991 and 2000. The results of these patients were compared to the group of 28 primary TKA patients with the same age, sex and operation time point. The long-term outcomes were evaluated using clinical and radiological analysis. The mean follow-up period of the patients was 10.5 years. The UKA revision patients were more dissatisfied, as measured by the WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index) scale (0–100 mm) compared to the primary TKA patients (pain 18.1/7.8; $p=0.014$; stiffness 25.7/14.4, $p=0.024$; physical function 19.0/14.8, $p=0.62$). Two patients were revised twice in the UKA revision group. There was one revision in the primary TKA group ($p=0.39$). Improvement in range of motion (ROM) was better in the TKA patients compared to the UKA revision patients ($8.2^{\circ}/-2.6^{\circ}$, $p=0.0001$). We suggest that UKA conversion to TKA is associated with poorer clinical outcome as compared to primary TKA.

Introduction

Due to continuous development of surgical techniques and component design since the early 1970s [11, 23], unicompartmental knee arthroplasty (UKA) has become a more successful and reliable treatment method for unicompartmental knee osteoarthritis. Several studies have reported that UKA is a viable option for the treatment of unicompartmental osteoarthritis and some authors have also even reported excellent outcomes, focusing attention on careful patient selection and correct indications [1, 3, 9, 17, 20, 26]. Advantages of UKA compared to total knee arthroplasty (TKA) are cost-effectiveness, fewer serious complications [21, 24] and better postoperative functional outcome [9, 27]. Increased risk of revision has been shown to be a disadvantage of this method [8].

When UKA failure occurs, a revision procedure to TKA is often necessary. Some authors have reported the outcomes of UKA revisions to be comparable with primary TKA and preferable to those of revised TKA [6, 16]. Others have found UKA revision patients to have a higher incidence of local wound complications and inferior clinical results compared to primary TKA patients [19]. The purpose of this study was to assess the long-term results of a failed UKA conversion to TKA compared to a primary TKA operation.

Patients and methods

During 1991–2000, 2949 total knee, 344 unicompartmental knee and 484 revision knee arthroplasties were performed in the Department of Orthopaedics and Traumatology, Kuopio University Hospital. During this time period, 44

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revisions of failed medial unicompartmental knee arthroplasties were performed. All the UKA revision patients included in this study had primarily medial unicompartmental knee osteoarthritis. The decision to perform the primary UKA was made by the surgeon during operation. After approval by the ethics committee of Kuopio University, the project began in May 2008 by sending all patients a letter of invitation to a follow-up examination in Kuopio University Hospital. Sixteen UKA revised patients had died (1991–2008) and six UKA revised patients, were not able to participate in the study for different reasons (dysphoria $n=2$, cancelled without stating reason $n=2$, excellent knee $n=2$). In addition, one patient did not fit the inclusion criteria because her UKA was converted to a new UKA. Thus, a total of 21 of the original 44 UKA revision patients were available for the minimum of eight years follow-up (mean 10.5 years; range eight–17 years) and are included in this report.

The UKA revision patients (group 1) were compared to a randomly selected TKA patients group ($n=56$) (group 2) whose age, sex and the operation time point were comparable to group 1. The number of control patients was based on the living UKA revision cases multiplied by two. Patients for the control group were randomly selected from the population of TKA patients having the same age, gender and operation time point distributions as UKA revised patients. Sixteen patients had died in this group and 12 patients were not able to participate in the study for different reasons (dysphoria $n=4$, cancelled without reporting the reason $n=5$, patient confined to bed $n=1$, not able to communicate $n=1$, moved $n=1$). Thus, the TKA group (group 2) consisted of 28 patients who had undergone primary TKA operation at the same time as the UKA patients had undergone the revision operation. Hence the final study population consisted of 49 patients (group 1, $n=21$; group 2, $n=28$).

The patients' characteristics including age, gender, medication, smoking, preoperative body mass index (BMI) and postoperative hospital stay were recorded from the medical case records. The formula for determining BMI is weight (kg) divided by height squared (m^2) (kg/m^2). The time from primary UKA to UKA revision as well as the mode of failure and requirement of augments, stems and bone grafts was recorded. All operations in both groups were carried out by the standard surgical technique. Five knee implant designs from three manufacturers had been used: AMK (Depuy, Warsaw, IN, USA), Duracon (Stryker Howmedica, NJ, USA), Miller-Galante (Zimmer, Warsaw, IN, USA), NexGen (Zimmer, Warsaw, IN, USA) and PCA (Stryker Howmedica, Rutherford, NJ, USA). The first follow-up visit was scheduled approximately three months after operation for patients in both groups. The postoperative three-month range of motion (ROM) and postopera-

tive complications were also recorded for the first time at the first follow-up.

The patients were invited to come to the Kuopio University Hospital for follow-up examination in June 2008, and a detailed clinical examination and interview were performed. The knee status included: ROM, stability, pain, scar length and self-reported walking distance. Walking ability and balance were measured with a timed "get-up and go test" [18]. BMI was measured and obesity was defined as BMI greater than $30 kg/m^2$ [4]. Any requirement for walking aids was also recorded.

Long, weight-bearing coronal and sagittal radiographs of the operated limb were performed. Alignment of the knee was evaluated, and the degree of the deviation of the mechanical axis was defined as the angle between a line from the femoral head to the centre of the knee joint and a line from the centre of the knee to centre of the ankle. A deviation of within ± 3 degrees from neutral was considered to be an acceptable outcome [14, 25].

Each patient also answered the WOMAC questionnaire (Western Ontario and McMaster Universities Osteoarthritis Index), which included 24 questions in three classes (pain, stiffness and physical function). The patients were given a VAS (visual analogue scale) version of WOMAC on a scale from 0 mm (no pain, stiffness or disability in physical function) to 100 mm (severe pain, stiffness or disability on physical function), and a sum of scores was calculated within all classes. Aggregate scores for each dimension were calculated as an average within all three classes [2].

Statistics

Statistical analysis was performed with the SPSS 14.0 software. Mann-Whitney test was used to evaluate the group differences in continuous variables. Pearson's chi-square test was performed for categorical variables. P value of ≤ 0.05 was considered significant. A statistician was consulted during the study.

Results

The mean age of the patients at the time of follow-up examination (June 2008) was 75 years (range 61–87, SD 7.21). There were 20 men and 29 women. The mean body mass index was $30.1 kg/m^2$ (range 18.3–47.0, SD 5.67). A total of 23 patients were considered obese based on BMI value greater than $30 kg/m^2$, eight of those were men and 15 women ($p=0.292$). There were no statistically significant differences between the study groups (group 1=UKA revision, group 2=TKA primary) regarding characteristics except smoking. Specific values and descriptive statistics

are shown in Table 1. The postoperative hospital stay for the patients who underwent UKA revision averaged 8.3 days (range 8–11, SD 1.05), and for the patients who underwent primary TKA it was 7.9 days (range 6–12, SD 1.83).

The mean time from primary UKA to revision in which UKA was converted to TKA was 5.4 years (range 1–11 years, SD 2.76). UKA failures were caused by polyethylene wear or breakage in 15 cases, loosening of the femoral or tibial component in four cases, progression of osteoarthritis in one case, and severe malalignment of the knee (22° valgus) in one case. UKA revision was performed in 21 knees using AMK (1), Duracon (6), Miller-Galante (3) and NexGen (11) implants. Four bone grafts, six stems and one augment were required in eight revision operations. The primary TKA was performed in 28 knees using AMK (3), Duracon (14), Miller-Galante (2), NexGen (7) and PCA (2) implants. In the UKA revision group, one patient had wound infection and therefore needed re-revision operation. One deep vein thrombosis was also recorded. In the primary TKA group three patients developed a superficial wound infection and all cases were treated by antibiotics. Three patients suffered from deep vein thrombosis and one patient had peroneal nerve injury (Table 2).

Two patients in group 1 needed the second and third revisions. In both cases the second revision was performed because of polyethylene wear. The first patient required a third revision, his tibial component was loose because of infection, and it was revised with a stemmed total knee prosthesis. The second case occurred because of knee instability and it was revised by using a stabilising total knee prosthesis. Thus two knees were revised twice and the revision rate of the patients in group 1 was two knees (9.5%) ($p=0.39$) and cumulative re-revision rate was four

knees (19%) ($p=0.077$). One patient in group 2 was revised for aseptic loosening (Table 2).

The clinical results after the eight to 17 years follow-up period are presented in Table 3. The patients who had undergone UKA revision operation (group 1) reported more pain, stiffness and physical dysfunction compared to the patients treated with primary TKA (group 2). The patients in group 2 were able to walk longer distances compared to those in group 1, but the difference was not statistically significant. Two patients (one in each group) had lateral knee instability (varus type), and one patient in group 2 had 15° flexion contracture. However, the patients were satisfied and further procedures were not required. There was no statistically significant difference in use of the walking aids. One patient in each group used a wheelchair (Table 2).

Parameters measured from weight-bearing coronal and sagittal radiographs did not differ between the study groups after the follow-up period of eight to 17 years. All implants were acceptably positioned. For the patients in group 1, the mean deviation of the mechanical axis of the lower limb was 3.6° (range 0–16, SD 3.5), and in group 2 it was 3.5° (range 0–10, SD 2.38) ($p=0.538$). The deviation from the straight mechanical axis was 3° or more in ten patients in group 1 and in 17 patients in group 2 ($p=0.374$).

The range of motion was measured for the first time postoperatively at the three-month follow-up visit. These values were available in 44 patients, because reliable preoperative values of the ROM were missing in five patients. Results were compared to those recorded at the time of the follow-up visit. The primary TKA patients reached poorer ROM by three months postoperatively, but improvement was better compared to UKA revision patients during the follow-up period (Table 3).

Table 1 Patients' characteristics

Description	Group 1 ($n=21$) (UKA revision)	Group 2 ($n=28$) (TKA primary)	p value
Male/female	9/12	11/17	0.80
Age (years $\pm$ SD)	74.9 $\pm$ 7.4	75.2 $\pm$ 7.2	0.88
Chronic diseases	17	25	0.41
Diabetes	6	11	0.44
ASO	2	0	0.095
Hypertension	16	19	0.52
Cardiac (FA, CAD, insuff)	8	15	0.28
Smokers	4	0	0.016
BMI at follow-up visit ($\text{kg/m}^2 \pm$ SD)	28.6 (4.6)	31.3 (6.2)	0.23
BMI perioperative ($\text{kg/m}^2 \pm$ SD)	28.5 (4.0)	30.5 (4.4)	0.28

UKA unicompartmental knee arthroplasty, TKA total knee arthroplasty, FA atrial fibrillation CAD coronary artery disease, Insuff insufficiency, BMI body mass index

Table 2 Clinical data of follow-up visit, complications and revisions per patient expressed as mean and number

Clinical data	Group 1 (<i>n</i> =21) (UKA revision)	Group 2 (<i>n</i> =28) (TKA primary)	<i>p</i> value
Range of motion (SD)	105.7° (12.9)	106.8° (12.3)	0.37
Walking distance (m) (SD)	3197 (2925.9)	2311 (2100.9)	0.37
Get-up and go test (s) (SD)	13.4 (12.5)	11.0 (3.8)	0.89
Skin incision (cicatrix, cm) (SD)	19.6 (1.9)	19.6 (2.3)	0.78
WOMAC pain (VAS 0–100 mm) (SD)	18.1 (18.1)	7.8 (8.1)	0.014
WOMAC stiffness (SD)	25.7 (20.3)	14.4 (14.3)	0.024
WOMAC physical function (SD)	19.0 (18.8)	14.8 (11.9)	0.62
Ambulatory support	9	11	0.80
Complications			
Wound infection	1	3	–
Thrombosis	1	3	–
Nerve injury ^a	0	1	–
Total complications	2 (9.5%)	7 (25.0%)	0.17
Re-revisions (per patient)	2 (9.5%)	1 (3.6%)	0.39

^a Peroneus nerve (verified with ENMG)

UKA unicompartmental knee arthroplasty, TKA total knee arthroplasty, WOMAC Western Ontario and McMaster Universities Osteoarthritis Index

Discussion

The UKA for the treatment of unicompartmental knee arthroplasty is still a controversial procedure. Kozinn et al. [15] suggested in their review that the best candidates for the UKA procedure with cement designs are over 60 years, non-obese and physically inactive patients. Harrysson et al. [10] also showed in their study from the Swedish Knee Arthroplasty register that both UKA and TKA patients younger than 60 years had a higher risk of early revision. A register study of 1,819 patients (mean age 65 years) from Finland found that younger patients (≤ 65 years) have increased risk to fall revision operation compared to older patients (> 60 years). They also showed that the number of UKA operations in Finland has been substantially increased during the past 20 years. Although the survival rate of UKAs has also improved in Finland, there are still too many surgical centres in which UKA operations are performed [12]. Koskinen et al. [13] also found in their recent study that UKA has substantially poorer (60%) survival rate compared to TKA (80%) at 15 years. They also disproved a conception of the cost-effectiveness of the UKA by finding that lower implant prices and shorter

hospital stays compared to TKA would not cover the costs of the revision operations.

Studies on clinical outcome comparing UKA revision and primary TKA are rare. Miller et al. [19] found that UKA revision patients had a higher complication rate and inferior clinical results (measured by Knee Society Score) compared to primary TKA patients. On the other hand, they also noticed that knee scores recovered in UKA revision patients when posterior cruciate ligament substituting designs were used. UKA revision knee replacement is a demanding operation; however, opinions vary on how it relates to primary TKA or TKA revision [7, 16]. Saragaglia et al. [22] evaluated the radiological and clinical results of 33 medial UKA converted to TKA revisions. When comparing their results to the literature, they suggested that UKA conversion to TKA operation would give better results than TKA revision. In any case, it is considered to be more difficult than the primary UKA operation [5]. In this study we found some differences in clinical outcome between UKA revision and primary TKA groups. Self-assessed WOMAC scores were significantly inferior in the UKA revision patients and improvement of ROM was worse during the follow-up period. We could not confirm

Table 3 Range of motion in the UKA revised and TKA operated knees at three months and long-term follow-up

Range of motion (ROM)	Group 1 (<i>n</i> =19) (UKA revision)	Group 2 (<i>n</i> =25) (TKA primary)	<i>p</i> value
ROM (post op) (SD)	107.9° (10.7)	99.8° (9.5)	0.017
ROM (June 2008) (SD)	105.3° (13.2)	108.0° (10.1)	0.21
Δ ROM	−2.6°	8.2°	0.0001

UKA unicompartmental knee arthroplasty, TKA total knee arthroplasty

the results of Miller et al. that there are significant difference in complications between UKA revision and primary TKA patients. The re-revision rate after a UKA procedure was converted to TKA has been previously reported to range from 4% to 14% [1, 6, 19]. The re-revision rate (group 1) in our study was 9.5% per patient and 19% per knee.

There were some limitations to this study. The number of UKA revision patients was small and there were several component designs used. The WOMAC scores were not in use preoperatively. The strengths of the study are the long follow-up times and the compatibility of the patient populations.

In conclusion, our results show that, in the long-term, the UKA revision patients were more dissatisfied according to the WOMAC scale. Improvement of the range of motion was less in UKA revised cases, although ROM at the follow-up was similar. However there were no statistically significant differences between the groups with regard to complications and radiological results. We suggest that UKA conversion to TKA is associated with poorer clinical outcome as compared to primary TKA.

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