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ORIGINAL STUDY

Minimally invasive unicompartmental knee arthroplasty in treatment of osteonecrosis versus osteoarthritis : a matched-pair comparison

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This study was conducted to compare the differences of the outcome and surgical technique for minimally invasive unicompartmental knee arthroplasty(UKA) in treatment of osteonecrosis versus osteoarthritis. Twenty-nine spontaneous osteonecrosis of the knee (SONK) cases were reviewed retrospectively. An equal number of patients with osteoarthritis (OA) performed in the same period were selected and matched with respect to age, preoperative range of motion and radiological grade of knee arthrosis. The mean follow up time were 44.14 ± 14.05 and 44.45 ± 14.45 months, respectively. The preoperative hospital for special surgery knee score and visual analogue score were significantly better in group OA than those of group SONK. However, the results were comparable in terms of postoperative pain, knee score, range of motion and axial alignment. From a technical point of view, the osteonecrosis stage and bone defect must be taken into account when using UKA for SONK.

Keywords : unicompartmental knee arthroplasty ; spontaneous osteonecrosis of the knee ; osteoarthritis ;minimally invasive ; medial unicompartment.

INTRODUCTION

Unicompartmental knee arthroplasty (UKA) is one of treatment options for patients with arthrosis of the medial compartment knee. As surgical techniques and instruments have improved, this procedure has shown many advantages in treatment of anteromedial osteoarthritis (AMOA) over total knee arthroplasty (TKA), such as less soft tissue injury, a smaller incision, minimal bone resection, preservation of normal knee kinematics, reduced hospital stay and more rapid recovery (*2,8,14,19*). Moreover, it appears quite reasonable to replace the only involved unilateral compartment of the knee. The mobile Oxford medial UKA (Oxford® Unicompartmental Knee, Biomet, Bridgend, UK) has been used successfully for more than three decades. Since 1998, the phase 3 implant has been introduced and widely used. Many excellent results for AMOA of this procedure in the long term have been reported (*6,12,20*).

Spontaneous osteonecrosis of the knee (SONK) is a bone necrosis disease that often leads to subchondral collapse and disabling arthritis (*9*). SONK

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usually affects the medial femoral condyle, which characterized by acute knee pain and tenderness of the medial femoral condyle. It's anatomical feature is similar to AMOA, such as focal loss of bone and cartilage in the medial compartment with the intact ligament and lateral compartment, which is indicated for UKA. Nevertheless, limited studies were published about UKA in SONK (*3,5,7,18*). The role of UKA in SONK remains unclear, particularly regarding the technical parameters compared with AMOA. This observational study was performed to investigate the outcome and surgical technique of minimally invasive UKA for SONK.

MATERIALS AND METHODS

Approval for the present study from the institutional review board was obtained. From January 2003 to March 2012, 29 patients who had received UKA for late-stage SONK were identified from medical records.

To compare the clinical outcome of medial UKA for SONK, a match paired control group of the equal number of patients operated on medial UKA for primary OA in the same period were selected and matched with respect to age, preoperative range of motion and radiological grade of knee arthrosis. These two populations were comparable in terms of age, follow-up, gender distribution and body mass index (BMI) (Table I). All UKA procedures were performed by the senior author.

The indications for UKA were severe medial knee pain and considerable difficulty in walking and performing daily activities. Radiograph can demonstrate SONK or OA of the medial compartment knee. SONK patients were at the late-stage with collapse of the medial compartment (Ahlbäck Grades III-IV) (*1*). The other indications were an intact anterior cruciate ligament (ACL), varus deformity < 15°, flexion contracture < 15°, intact lateral compartment (*10*).

All patients were placed in the supine position on a standard operating table after spinal anesthesia had been administered. A tourniquet was applied to the proximal thigh on the operative side and inflated to 300 mmHg. A medial parapatellar incision was used and the patella was not everted. In group SONK, osteonecrotic bone was completely removed and filled with autologous bone graft harvested from the bone removed at surgery.

Clinical outcomes were evaluated by measuring the difference among duration of surgery, blood loss, hospital stay, complication, the range of knee motion (ROM), visual analogue score (VAS) and Hospital for Special Surgery (HSS) knee score. Weight bearing anteroposterior and lateral radiographs of the knee were obtained, as well as a long hip-to-ankle film to assess the femorotibial angle (FTA) and implant position. Loosening of the components was identified by an area of radiolucency > 2 mm around the components. Over rotation of the component was diagnosed if the alignment angle exceeded 10°. Each evaluation was made twice by two independent observers. The endpoint for survival was defined as revision for any reason. Patient-related information was collected using a standardized questionnaire administered before surgery and at follow-up.

All data were analyzed using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA). Data are reported as the mean with the standard deviation. The chi-squared test and Student's t test were used to determine whether there were statistically significant differences between the groups. A p value < 0.05 was considered statistically significant (*11*).

Table I. — UKA Demographics

	SONK	OA	t Value	P Value
Number (knees)	29	29		
Age (years)	63.83 ± 9.23	65.69 ± 11.07	0.70	0.49
Gender (male:female)	12/17	12/17		
Mean follow up (months)	44.14 ± 14.05	44.45 ± 14.45	0.083	0.934
BMI (kg/m^2)	25.44 ± 3.48	24.21 ± 3.71	1.311	0.195
Preoperative HSS score	55.69 ± 7.82	61.76 ± 8.58	2.815	0.007
Preoperative VAS score	7.28 ± 0.75	6.62 ± 1.08	2.677	0.010
Preoperative range of motion	123.71 ± 9.88	122.23 ± 10.06	0.566	0.574
Preoperative femorotibial angle	180.63 ± 3.05	181.41 ± 2.76	1.018	0.313

RESULTS

One patient died from lung cancer after 3 years in group OA. There was no clinical symptom of implant failure or radiographic sign of loosening at last follow up. At baseline, all the other 57 patients in the group were recruited at the final follow up. The average length of time between surgery and the final follow up was 44.14 ± 14.05, 44.45 ± 14.45 months (range, 24~69 months), respectively (Table I).

The preoperative HSS score and VAS score were significantly better in group OA than those in group SONK ($p = 0.007$ and 0.010). However, no significant differences were found between groups in postoperative HSS score and VAS score ($p = 0.153$ and 0.413). Changes of HSS score and VAS score after operations were significantly greater. In group SONK, the mean preoperative HSS knee score improved from 55.69 ± 7.82 to 93.45 ± 4.73 ($t = 21.57$, $p = 0.000$). In group OA, the preoperative HSS mean score improved from 61.76 ± 8.58 to 91.59 ± 5.05 ($t = 15.48$, $p = 0.000$). VAS score were reduced from 7.28 ± 0.75, 6.62 ± 1.08 to 1.97 ± 1.02, 2.17 ± 0.89 in SONK and OA group, respectively (SONK, $t = 24.48$, $p = 0.000$; OA, $t = 17.38$, $p = 0.000$). For the SONK and OA groups, the mean preoperative range of motion were 123.71 ± 9.88°, 122.23 ± 10.06°, respectively ($t = 0.566$, $p = 0.574$). No significant differences were found in postoperative range of motion between groups (SONK, 127.35 ± 7.30° ; OA, 126.59 ± 6.39° ; $p = 0.675$). Besides, the significant differences were not existed in the preoperative and postoperative axial alignment between groups.

The average operation time of the groups were 78.59 ± 12.67, 63.90 ± 13.84 minuets, respectively, and there was a significant difference between the two groups ($t = 4.216$, $p = 0.000$, < 0.05). There was a trend toward a more blood loss in SONK group, although this did not achieve statistical significance (SONK 203.24 ± 76.93 ml ; OA 185.66 ± 64.25 ml ; $t = 0.945$, $p = 0.349$). Besides, no significant differences were found in the hospital stay after surgery between groups (Table II).

In SONK group, one UKA was revised to a TKA after 3years as a result of the lateral tibial plateau and fibular head fracture sustained in a major trauma. There had been no clinical symptoms of implant failure or radiographic signs of loosening before the accident. In OA group, one of the 29 prostheses included in the analysis had been revised to a TKA as a consequence of infection 1 year after surgery ; with the endpoint of revision for any reason the survival rate was 96.6%. Bearing dislocation occurred in one OA case at 1.5 years after surgery because of laxity after hyperflexion trauma ; the bearing was replaced by thicker one. No recurrence of luxation was seen at follow-up. One diagnosis of lateral compartment osteoarthritis was made in group OA. Two patients in each group reported continuing unexplained pains. There were no serious adverse events related with operation in both groups, such as death, pulmonary embolism, deep venous thrombosis, cardio-cerebral vascular incident or psychogenia.

According to the guidelines proposed by the Oxford Group *(4)*, postoperative radiographic

Table II. — Comparison after UKA in SONK and OA

	SONK	OA	t Value	P Value
Number (knees)	29	29		
Duration of surgery (minuets)	78.59 ± 12.67	63.90 ± 13.84	4.216	0.000
Blood loss (ml)	203.24 ± 76.93	185.66 ± 64.25	0.945	0.349
Hospital stay (day)	6.83 ± 1.47	6.48 ± 1.55	0.871	0.388
Postoperative HSS score	93.45 ± 4.73	91.59 ± 5.05	1.450	0.153
Postoperative VAS score	1.97 ± 1.02	2.17 ± 0.89	0.825	0.413
Postoperative range of motion	127.35 ± 7.30	126.59 ± 6.39	0.422	0.675
Postoperative femorotibial angle	177.97 ± 2.22	179.00 ± 2.57	1.627	0.109

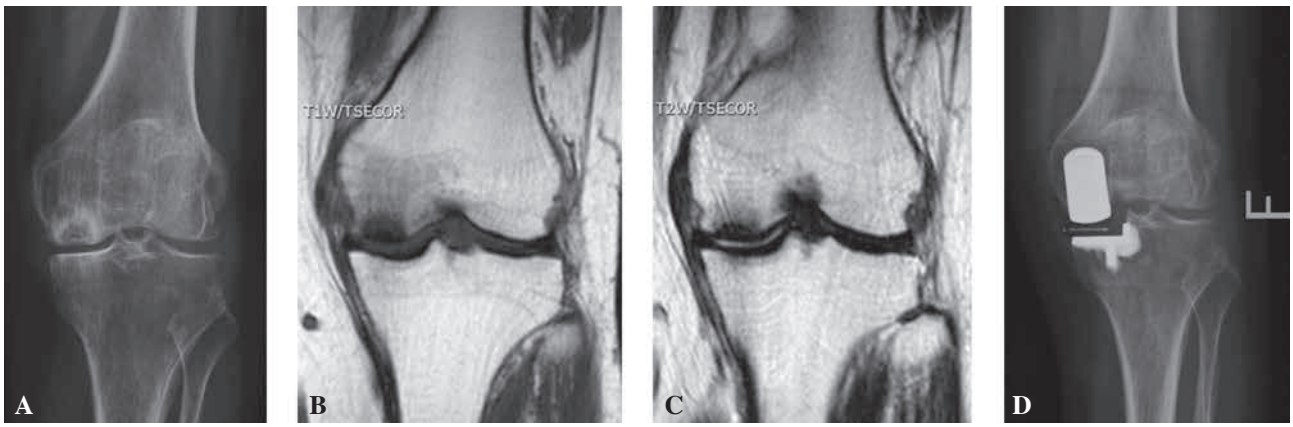

Fig. 1. — A case of a 65-year-old woman with SONK.
(A) Anteroposterior standing radiogram of the knee prior to surgery. (B) T1-weighted image of the same knee showing focal lesion of the medial condyle. (C) T2-weighted coronal image of the same knee showing focal lesion of the medial condyle. (D) UKA at 2 years of follow-up on AP view.

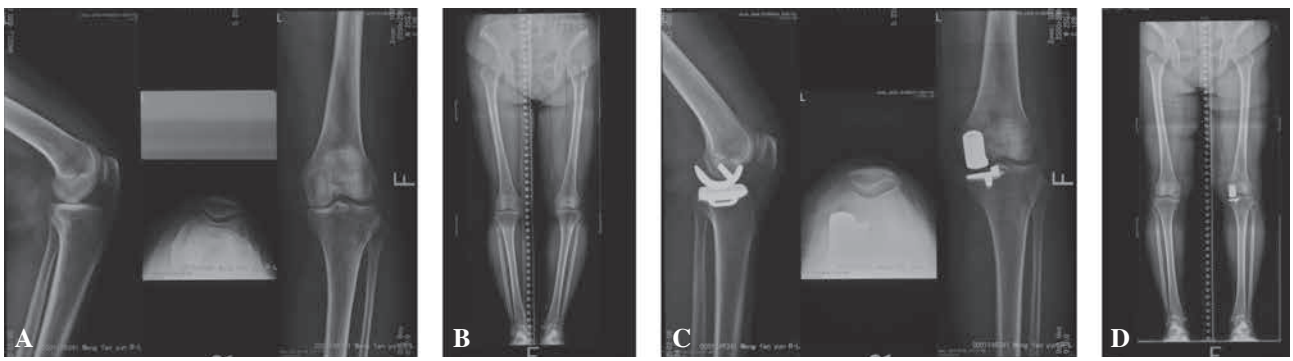

Fig. 2. — A case of a 63-year-old woman with OA.
(A) Radiogram of the knee prior to surgery. (B) A long hip to ankle film for measuring the femorotibial angle. (C) Radiogram of the knee after UKA surgery. (D) UKA at 2 years of follow-up on a long hip to ankle film.

assessments showed that one component in each group was not in an acceptable position. One implant in group SONK was undercorrected and one femoral component in group OA tilted with postoperative radiographic angle > 10°. Two radiolucent lines were observed in group SONK, compared with 1 radiolucent line in group OA. All the three radiolucent lines were occurred on the tibial sides but nonevolutional with time. There was no clinical symptom of implant failure at last follow up (Figs. 1-6).

DISCUSSION

Unicompartmental arthroplasty is a well-recognized treatment option for unicompartmental osteoarthritis of the knee. Svard and Price reported a 95% cumulative survival rate over 10 years (*19*). Pandit reported the outcomes of 1000 phase 3 Oxford medial UKAs using a minimally invasive surgical approach by two surgeons. Using revision as the end point, the 10-year survival rate was 99.8% (*13*). In 2011, Price reported the second decade data of the

Fig. 3. — Anteroposterior X ray of a 49-year-old female with postoperative infection of UKA.

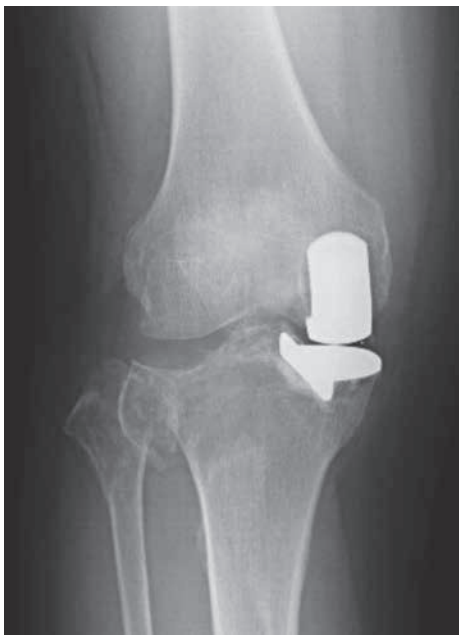

Fig. 4. — Lateral tibia plateau and fibular head fracture at postoperative 3 years after arthroplasty in SONK.

UKA, having previously reported longitudinal data from 1, 6, and 10 postoperative years (*15-17*). In the most recent study, postoperative function and HSS score had still significantly improved from baseline. These findings suggested that UKA is a reliable treatment option for anteromedial osteoarthritis of the knee.

In 1968, SONK was described as a typically unicompartmental disease by Ahlbäck (*1*). More recently, Mont reported the limited involvement of the periarticular bone in this disease. SONK mainly affects the medial femoral condyle (*9*). Although its etiology is poorly understood, its anatomical features is similar to AMOA (focal loss of bone and cartilage in the medial compartment with the ligament intact). Therefore, UKA seems to be an appropriate procedure, particularly for patients older than 65 years with unaffected lateral and patellofemoral compartments. Some surgeons believe joint arthroplasty is the only reasonable treatment for SONK with secondary articular collapse (*3,5,18*).

Recently, several studies have shown excellent functional outcome and survivorship of UKA in treatment of SONK. Bruni reported 84 patients with late-stage SONK, with the follow-up of 98 months. The overall survival was 89%. Ten revisions were performed ; the most common failure reasons were subsidence or aseptic loosening of tibial component. No patient underwent revision for progression of osteoarthritis in the lateral or patellofemoral compartments (*3*). Similarly, Langdown assessed 29 knees (27 patients) with SONK using the Oxford Knee with 5 years follow-up. They confirmed that Oxford Medial UKA for spontaneous focal osteonecrosis of the knee is reliable in the short to medium term, and gives results similar to primary OA (*7*). Servien reported a comparison study of 33 SONK and 35 OA. The mean follow-up was 5 years. The results were comparable in terms of pain, knee score and function. The survival rate was 92.8% for group SONK and 95.4% for group OA. A higher rate of radiolucencies in group SONK was found, although no clinical symptoms (*18*).

However, our study is a prospective continuous study with an anonymous and independent database and with a match paired group. Although the preoperative HSS score and VAS score were significantly better in group OA than those in group SONK, the

Fig. 5. — Posterior dislocation of the bearing in OA group

Fig. 6. — Lateral compartment osteoarthritis in OA group after UKA.

postoperative results were comparable in terms of pain and knee score. Besides, no significant differences were found in the postoperative blood loss, hospital stay, range of knee motion, radiographic assessment and incidence of complication between groups. Minimally invasive UKA is an effective method for spontaneous osteonecrosis of the knee.

The medium-term outcome of UKA in SONK is encouraging. However, patient's selection and surgical techniques in SONK are different with those of OA and UKA may be very challenging in SONK. In the treatment of SONK, extend and stage of the lesion should be assessed before surgeon's plan. If the avascular necrosis is in the early stage, surgical intervention may cause extensive loss of bone and may require TKA with complex augments to make up for the bone defect. When the avascular necrosis has matured and been at late stage, it is much more amenable to UKA, as the remaining defect will be quite evident and it is usually surrounded by sclerotic bone.

From a technical point of view, implantation of UKA in SONK is a demanding procedure, and some considerations must be taken into account when using UKA for SONK. First, the bone collapse and defect of the medial femoral condyle often locate in the weight-bearing area in extension. Failure to identify the presence of bone defect may lead surgeon recessing the spigot too deeply and thereby milling too much bone from the medial condyle. This may result in imbalance between the extension gap and flexion gap. Second, as the osteonecrotic bone lesion was surrounded by sclerotic bone, removing the avascular necrosis bone lesion completely may be difficult with the Oxford mill tool, so the scoop can be used to remove osteonecrotic lesion and sclerotic bone could be used as a reference. Third, it is necessary for large craters to be filled with autologous bone graft harvested from the bone removed at surgery ; otherwise, bone defect might cause instability of components.

Nevertheless, there were still a few of potential weaknesses in this study. Firstly, the quality of prospective matched-pair study is weaker than randomized controlled trial. However, it is difficult to provide methodology of blinding and random

comparison to study two diseases with operation. Besides, only 29 UKAs for late-stage SONK were identified in the past ten years. The small sample can be explained by low incidence of the SONK in the general population. Finally, the follow up time may be not long enough. Some complications, such as loosening and revision, might occur in the later stage. Long-term study is still needed to elaborate the result.

Based on the study, minimally invasive UKA for medial unicompartmental late-stage SONK is a reliable procedure with excellent clinical and radiological results. The medium-term outcome of UKA is comparable with OA.

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