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Original Article

Effect of tibial component position on short-term clinical outcome in Oxford mobile bearing unicompartmental knee arthroplasty

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A B S T R A C T

Background: Malposition of the tibial components is a well-known complication of unicompartmental knee arthroplasty. In this study, we aimed to ascertain the relationship between the tibial component position and clinical outcomes of unicompartmental knee arthroplasty. We focused on the tibial component height and obliquity in the coronal plane.

Methods: Patients with anteromedial osteoarthritis who underwent Oxford mobile-bearing unicompartmental knee arthroplasty ($n = 45$) were included, and their Oxford knee score was assessed prior to and 1 and 2 years following surgery. We also assessed the postoperative tibial component position in the coronal plane using radiography, measuring the tibial component height and obliquity. We analyzed the sequential change in both clinical scores using repeated measures analysis of variance ($p < 0.05$). The effects of tibial component position on the clinical outcomes were analyzed using linear regression analysis ($p < 0.05$).

Results: The Oxford knee score significantly improved 1 year after surgery. The tibial component height and obliquity had a significantly negative correlation with the 2-year postoperative Oxford knee score. They were also correlated significantly with Oxford knee score recovery after unicompartmental knee arthroplasty.

Conclusion: The 2-year postoperative outcomes of Oxford unicompartmental knee arthroplasty depended on the tibial component position. We observed poorer outcomes when the tibial component was placed at a lower level relative to the lateral compartment and when there was an excessive valgus angle relative to the lower limb axis.

1. Introduction

In patients with anteromedial osteoarthritis (OA), Oxford mobile-bearing unicompartmental knee arthroplasty (UKA) provides significant benefits [1], with good long-term outcomes, including quicker recovery and lower rates of morbidity and mortality. Recent studies show that good clinical outcomes can be achieved using Oxford mobile-bearing UKA in patients with medial compartment disease [2–7].

Regarding tibial component position in the coronal plane in UKA, the height of the tibial prosthesis affects prosthesis survival. It should be preserved within 3 mm in either direction of the lateral compartment joint space height to restore the balance between the two femoro-tibial compartments to increase prosthesis survival [8]. In addition, if the transverse tibial cut is placed too distally, the tibial implant rests on the cancellous bone, offering less resistance to compression forces, as demonstrated by Iesaka et al. [9]. Tibial component obliquity is another variable affecting joint kinematic restoration and bone resistance to loading [10]. Physiological obliquity of the femoro-tibial joint space, approximately 3° varus, should be restored to <3° in either direction for prosthesis survival [8]. Restoring joint space height and achieving optimal tibial component obliquity are crucial in terms of both joint mechanics and joint kinematics.

However, the direct relationship between tibial component height (TCH) and obliquity and clinical outcomes has not been clearly described.

Abbreviations: OA, Osteoarthritis; UKA, Unicompartmental knee arthroplasty; TCH, Tibial component height; HKA, Hip Knee Ankle; AKI, Ankle Knee Implant; TOL, Tibial component obliquity relative to lateral compartment; OKS, Oxford Knee Score.

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We investigated the TCH and obliquity in the coronal plane to identify whether these could influence the clinical outcomes after Oxford UKA.

2. Materials and methods

The study protocol was approved by our hospital ethics committee. The patients provided informed consent for inclusion in this study. The other inclusion criteria were substantial pain and loss of function due to anteromedial OA of the knee [1]. All patients had primary OA of the medial compartment with full-thickness lateral compartment articular cartilage and an intact anterior cruciate ligament. In addition, patients whose outcome scores could be measured in the outpatient clinic 2 years after their surgery were included in the study. The exclusion criteria were knees with fixed flexion of >15°, active knee joint infection, and bilateral UKA. In total, 45 knees meeting the abovementioned inclusion criteria, which underwent primary medial Oxford UKA (Zimmer Biomet, Warsaw, IN) between 2012 and 2015, were enrolled. The patient population comprised 32 women and 13 men (age, 73.4 ± 7.7 years; body mass index, 25.6 ± 3.4 kg/m^2). The average preoperative coronal plane alignment on standard weight-bearing anteroposterior radiographs of the patients was 7.1 ± 4.8° in varus. All UKA procedures were performed by the author or surgeons directly under his instruction.

2.1. Surgical procedures

All surgeries were performed in accordance with the Oxford partial knee surgical technique. An inflatable thigh tourniquet was used, with the draped leg on a thigh support, the hip flexed to approximately 30°, and the leg dependent. We used a minimally invasive approach and incised the skin from the medial margin of the patella to a point 3 cm distal to the joint line. A deep incision was created through the joint capsule. At its upper end, the capsular incision was extended proximally 1 cm into the vastus medialis.

After removal of osteophytes, the tibia was cut in the same manner. First, a horizontal cut was created with reference to the posterior condyle of the femur using the microplasty instrument and tibial saw guide, which had a 7° of built-in posterior slope set parallel to the long axis of the tibia in the coronal and sagittal planes. Second, we created a vertical cut at the medial edge of the anterior cruciate ligament insertion on the tibia with the blade directed at the anterior superior iliac spine.

A femoral saw cut was also created with the drill guide linked to the intramedullary space.

After femoral saw cutting, we performed gap balancing using the feeler gauge in the same manner.

2.2. Postoperative assessment of tibial component position

Weight-bearing anteroposterior and lateral radiographs and a long-leg radiograph were obtained before and between 3 and 6 months after surgery.

To assess the tibial component position in the coronal plane, radiographic parameters were analyzed (Fig. 1a and b). The hip-knee-ankle (HKA) and ankle-knee-implant (AKI) angles were analyzed to assess overall lower limb malalignment. The angle subtended by the tangent to the tibial component and the line prolonging the lateral femoro-tibial joint space were analyzed to assess the tibial component obliquity, with valgus angles provided with positive values and varus angles with negative values (TOL: tibial component obliquity relative to the lateral compartment).

The height difference between the top of the medial intercondylar eminence and the line in contact with the lower surface of the tibial prosthesis was analyzed to assess the level of the tibial prosthesis relative to the top of the medial intercondylar eminence (TCH-I: TCH relative to the intercondylar eminence). Finally, the height difference between the tangent to the lower tibial component joint surface and the lateral femoro-tibial joint space was analyzed to assess the level of the tibial prosthesis relative to the lateral joint (TCH-L: TCH relative to the lateral joint).

2.3. Bearing size

We evaluated the bearing size to clarify whether the height of the tibial component depends on an unnecessary excessive tibial osteotomy.

2.4. Patient-reported outcome scores

The Oxford knee score (OKS) has been proven to be a reliable and valid instrument for self-assessment of knee pain and function in Japanese-speaking patients with knee OA and other knee complaints in a recent study [11].

We evaluated patient-reported measurements using the OKS (0–48 points) before and 1 and 2 years after UKA.

2.5. Statistical analysis

All radiographic measurements were performed by an orthopedic surgeon and were repeated at 2-month intervals. To evaluate intra-observer and inter-observer reproducibilities, the measurements were performed twice by one surgeon and once by another examiner on 10 knees randomly selected from the study group. The intra-class correlation coefficients between the two measurements of the same observer were 0.94, 0.96, 0.91, 0.88, 0.84, and 0.87 for pre- and postoperative HKA angles, AKI angle, TOL TCH-I, and TCH-L, respectively. The interclass correlation coefficient was calculated from the mean of the two measurements of the investigators and the measurements of the other investigators. The coefficients of the angle were 0.96, 0.93, 0.84, 0.86, 0.83, and 0.86, respectively.

All values were presented as means ± standard deviations. The results were analyzed using StatView 5.0 (Abacus Concepts Inc., CA, USA).

Sequential changes in the OKS were first analyzed using repeated measures analysis of variance ($p < 0.05$). We then performed linear regression analysis to assess the correlation between the tibial component position (AKI angle, TOL, TCH-I, and TCH-L) and OKS and assessed the relationship between TCH and obliquity (AKI angle, TOL), bearing size and TCH.

Statistical power analysis was performed before the study, which was expected to require a power of 0.8 based on a prespecified significance level of $\alpha < 0.05$, assuming a medium effect size (effect size $f^2 = 0.3$) using G power 3 [12]. The estimated sample size was 27 patients. P-values < 0.05 were considered statistically significant.

3. Results

3.1. Tibial component position

The mean HKA angle was 5.2 ± 4.09° preoperatively and 3.1 ± 2.78° postoperatively. The mean AKI angle was 88.4 ± 2.6° (range, 82.5–93.7), and the mean TOL was 1.59 ± 2.6° (range, −3.6-7.2) of valgus. The mean TCH-I was 15.7 ± 2.7 mm (range, 9.7–22.4), and the mean TCH-L was 9.60 ± 3.1 mm (range, 2.8–17.4).