Preoperative Factors Involved in Dislocation of Mobile Bearing after Oxford Medial Unicompartmental Knee Arthroplasty

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Abstract

Objective: Mobile bearing dislocation following Oxford Unicompartmental Knee Arthroplasty (UKA) is one of the most common causes of revision surgery. However, there have been no studies on the predisposing factors for this complication. Hence, in this study, we evaluated the preoperative risk factors for mobile bearing dislocation.

Methods: A total of 478 knees underwent Oxford UKA from 2010 to 2016 in our institution. Among these, 20 knees had mobile bearing dislocation, but only 19 knees were included in this study as there was no pre-operative MR data for one knee. By matching sex and age, thirty-eight knees were selected for the control group, which did not have dislocation. Demographic data, preoperative risk factors including meniscal extrusion, and radiological calculations were evaluated. Using multivariate logistic regression analysis and a receiver operating characteristic curve, we determined significant risk factors.

Results: Mean Medial Meniscus (MM) extrusion was 4.6 mm in the dislocation group and 3.5 mm in the control group. Regression analysis showed that only MM extrusion was a significant factors in bearing dislocation (odds ratio, 1.592; 95% confidence interval, 1.067 to 2.375) the cut-off value was 3.16 mm.

Conclusion: Pre-operative medial meniscal extrusion is a significant risk factor in mobile bearing dislocation after Oxford UKA.

Keywords: Medial compartment osteoarthritis; Unicompartmental knee arthroplasty; Mobile bearing, Bearing dislocation; Meniscus extrusion

Introduction

Mobile bearing Oxford medial Unicompartmental Knee Arthroplasty (UKA) is the procedure of choice for treatment of medial compartmental osteoarthritis. Many studies have reported good long-term outcomes of this surgery [1-3]. However, mobile bearing dislocation is still of concern, as it is a critical complication which requires revision surgery [4,5]. To prevent this complication, advanced implant design, such as a two-peg design, and new instruments, such as the microplasty system, have been developed to minimize misalign mentor mal position of implants [6,7]. Although Goodfellow et al. [8] reported that the risk of dislocation has become less frequent as implant design has progressed, recent studies have reported that there is still a high prevalence of dislocation following Phase III Oxford UKA, especially in the East Asian population [5,9,10].

A previous study evaluated the risk factors and the causes of dislocation [11]. By comparing the position of the femoral and tibial implants in patients who experienced dislocation to those of a control group, they reported decrement in Posterior Tibial Slope (PTS) after operation as the main risk factor. However, preoperative factors were not evaluated in that study, and no study has evaluated preoperative factors that predispose patients to dislocation.

East Asians have certain unique constitutional traits of the knee joints. In general, they have increased rates of varus knee alignment [12,13], higher incidences of meniscal root tears and extrusion [14,15], and more discoid lateral menisci [16]. Uncorrectable varus alignment or problems in lateral compartments have been considered as relative contraindications to mobile bearing UKA [8]. However, no previous study addressed the effect of meniscal extrusion on mobile bearing UKA.

Table 1: Patient Demographics.

Characteristic	Dislocation Group	Control Group	P value
Age (yrs, mean ± SD)	62.8 ± 6.7	61.3 ± 6.8	1.000*
Gender (M:F)	1:18	2:36	0.635*
BMI (kg/m², mean ± SD)	26.9 ± 2.6	25.9 ± 2.7	0.170*
Side (R:L)	6:13	19:19	0.190*
Femoral Component (n(%))			
Extra small	9(47%)	21(55%)	
Small	9(47%)	16(42%)	
Medium	1(5%)	1(3%)	0.709†
Large	0(0%)	0(0%)	
Extra large	0(0%)	0(0%)	
Tibial Component (n(%))			
AA	7(37%)	21(55%)	
A	4(21%)	8(21%)	
B	5(26%)	6(16%)	0.469†
C	3(16%)	3(8%)	
D	0(0%)	0(0%)	
Polyethylene bearing (n(%))			
3	8(42%)	17(45%)	
4	10(53%)	17(45%)	
5	1(5%)	3(8%)	0.940†
6	0(0%)	1(3%)	
0	0(0%)	0(0%)	

*Mann-Whitney U test
†Fisher's exact test

Because mobile bearings can be replaced by injured menisci, meniscal own pathology can be reflected; however, the pathognomomic changes around the injured meniscus can still be a problem.

Therefore, in the current study, we aimed to evaluate the possible causes for mobile bearing dislocation. Using pre-operative MR imaging, we hypothesized that intra-articular factors, such as meniscal extrusion, may be associated with mobile bearing dislocation.

Materials and Methods

After obtaining approval from our Institutional Review Board, we retrospectively studied the medical records of all patients who underwent Oxford UKA at our institution from 2010 to 2016. Among the 478 UKAs, 20 patients experienced bearing dislocation. Overall, the prevalence of mobile bearing dislocation was 4.2%. Because one patient had no preoperative MR data, only 19 knees were included in this study in the dislocation group. The control group consisted of 38 knees, for a ratio of 1:2, which were matched by age and gender. To maximize the follow-up period of the control group, we only selected patients operated on between 2010 and 2011. Pre-operative demographic data revealed no significant differences between the two groups (Table 1).

Surgical procedures

UKA was performed on patients with medial compartment osteoarthritis, without involvement of other compartments, no joint instability, and normal collateral and cruciate ligaments. UKA is generally contraindicated in patients suffering from inflammatory arthritis, limited range of motion (under 90 degrees), and severe varus knee alignment (over 15 degrees). All surgeries were performed in accordance with the surgical guidelines of Biomet, with protection of the MCL and medial structures. Intra-operatively, insufficiency of medial collateral structures and gap balance were checked to prevent postoperative bearing dislocation or unbalancing. Continuous passive motion exercises, quadriceps-strengthening exercises, and ambulation exercises were begun on post-operative day 2. Bearing dislocation was treated by swapping the bearing out for a thicker one or by converting to total knee arthroplasty.

Radiological evaluation

All patients undergoing UKA were evaluated with preoperative MRI scans. Human error was minimized by using the Star PACSPi View system (INFINITT Co. Ltd., Seoul, South Korea), as all measurements were taken by a single observer. Medial joint height, Medial Meniscus (MM) extrusion, and amount of effusion were measured (Figure 1). In coronal proton-density fat-saturated MR images, medial joint height was measured as the vertical distance between the cortical margin of the Medial Femoral Condyle (MFC) and the Medial Tibial Plateau (MTP). PMM extrusion was measured according to a previous study [17]; it is the distance from the most peripheral aspect of the medial tibial plateau, excluding the osteophytes, to the peripheral edge of the medial meniscus in the midline of the joint at the level of the MCL. To quantify joint effusion, we measured the antero-posterior diameter in the lateral aspect of the suprapatellar pouch in sagittal proton-density fat-saturated MR images [18].

We also evaluated a radiologic factor related to implant positioning, the PTS, because it was the only factor previously shown to potentially be related with bearing dislocation [11]. PTS was measured in the pre-operative lateral view as the angle between the joint line of the medial tibial plateau and the anterior line of the tibial shaft. Post-operatively, in true lateral view, we also measured the angle between the joint line of the tibial implant and the anterior line of the tibial shaft. The difference between these two angles was defined as PTS difference.

Statistical analysis

Demographic data and pre-operative risk factors in both groups were compared using the Mann-Whitney U test and Fisher's exact test. Backward stepwise multivariate logistic regression analysis was used to identify the reliability of risk factors. Receiver Operating Characteristic (ROC) curve analysis of the significant determinants was also performed to identify the optimal cut-off values for predicting dislocation. Using the common reference point of MM extrusion, 3 mm [17,19], we also calculated the odds ratio by Chi-square test. A p-value <0.05 was taken to indicate statistical significance, and all statistical analyses were performed using SPSS 12.0 (SPSS Inc., Chicago, Illinois).

Results

There were statistically significant differences between the two groups in two parameters: (a) Mean MM extrusion was 4.6 mm in the dislocation group *vs.* 3.5 mm in the control group, and (b) Mean medial joint height was 3.4 mm in the dislocation group and 2.6 mm in the control group. Regarding effusion, postoperative PTS and PTS differences between the groups were not statistically significant (Table 2). In backward stepwise multivariate logistic regression analysis, only MM extrusion was a significant determinant of bearing dislocation. The odds ratio was 1.592 and the 95% Confidence Interval (CI) was

Table 2: Pre-operative MR and Posterior Tibial Slope Change (Mean ± SD).

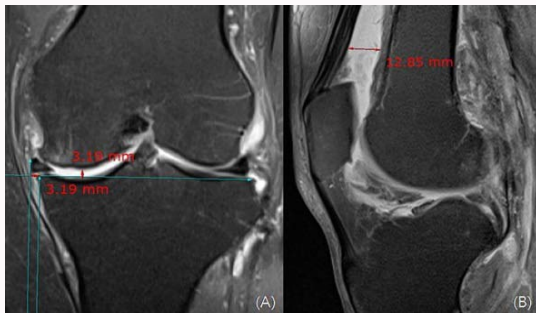| Characteristic	Dislocation Group	Control Group	P value
Medial joint height (mm)	3.4 ± 1.2	2.6 ± 0.9	0.025*
MM extrusion (mm)	4.6 ± 1.3	3.5 ± 1.6	0.011*
Amount of effusion (mm)	9.5 ± 5.5	8.3 ± 5.3	0.509
Preoperative PTS (°)	12.4 ± 3.9	12.2 ± 3.7	0.722
Postoperative PTS (°)	8.9 ± 4.0	10.7 ± 3.1	0.203
PTS difference (°)	3.5 ± 4.3	1.5 ± 4.4	0.14

*p<0.05 on Mann-Whitney U test

Figure 1: Pre-operative MR measurements. **(A)** Medial joint height and MM extrusion were measured on mid coronal proton-density fat-saturated MR images. Medial joint height is the vertical distance between the Medial Femoral Condyle (MFC) and the Medial Tibial Plateau (MTP) on the mid-MFC level. MM extrusion is defined as the medial displacement of the medial border of the medial meniscus from the medial border of the MTP, excluding the osteophytes. **(B)** The extent of effusion was measured by anteroposterior length in the lateral aspect of the suprapatellar pouch on sagittal proton-density fat-saturated MR images.

1.067 to 2.375.

ROC curve analysis of MM extrusion is shown in Figure 2. The area under the curve was 0.709 and the 95% CI was 0.573 to 0.845. The optimal cut-off value was 3.16 mm, with a sensitivity of 89.5% and a specificity of 55.3%. In a Chi-square test using the reference point of 3 mm, the sensitivity was 94.7%, the specificity was 44.7%, and the p-value was 0.007.

Discussion

The purpose of the current study was to identify, predict, and prevent pre-operative risk factors of bearing dislocation after mobile bearing UKA. The results showed that meniscal extrusion is the most significant and the only reliable factor in predicting bearing dislocation. This finding may be related to problems in medial collateral structures such as the MCL or medial capsule.

Functional insufficiency of ligament structure is a contraindication of mobile bearing UKA. Goodfellow et al. [8] noted that an absent or severely damaged ACL (or PCL or MCL) is an anatomical contraindication. Commonly, physicians who perform Oxford UKA are well-acquainted with the importance of the medial collateral structures and take care to prevent damage to the MCL during surgery. However, patients with bearing dislocation experienced a loosening of the medial collateral structures which did not exist during the initial surgery, and surgeons used a thicker bearing to solve this loosening and dislocation [8,11]. We also found similar, unexpected loosening of the medial collateral structures in our patients; therefore, we tried to identify factors that would predict this condition.

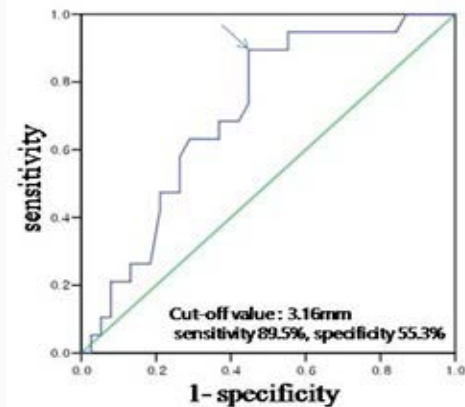MM extrusion is closely related to medial collateral structures,

Figure 2: Receiver Operating Characteristics (ROC) curve of MM extrusion and bearing dislocation. The optimal cut-off value that balanced sensitivity and specificity was 3.16 mm. AUC (Area Under Curve), 0.709; 95% CI (Confidence Interval), 0.573 to 0.845.
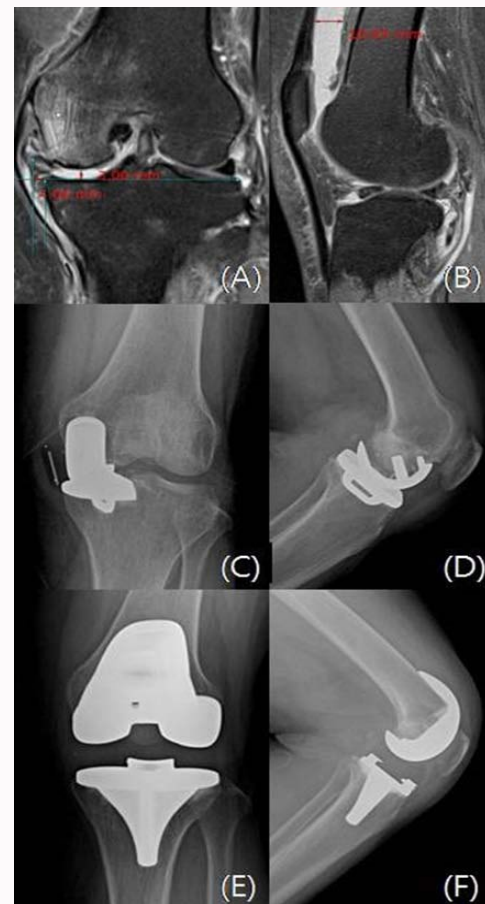

Figure 3: A 64-year-old female patient underwent Oxford UKA on her left knee one year prior. (A,B) Preoperative MR image showing a 4 mm extrusion. Six months after the initial surgery, the mobile bearing had dislocated and was changed to a thicker one (6 mm). (C,D) Unfortunately, the thicker bearing also dislocated after another 6 months. The dislocated bearing had moved to the medial gutter, an unusual site for dislocation because of its narrowness. (E,F) Because of uncontrolled medial laxity, the knee was treated with total knee arthroplasty with at hick polyethylene liner (18 mm).

including the medial collateral ligament. Blankenbaker et al. [17] reported that MCL edema is associated with meniscal extrusion,

in that all patients with meniscal extrusion over 3 mm had MCL edema. Because an extruded meniscus stretches the MCL, the MCL can become edematous and weaken. Furthermore, Aydingoz et al. [19] reported that the anteromedial capsulo femoral band appeared thicker in MRI images of patients with medial meniscus extrusion over 3 mm. They speculated that such thickening may compromise the loss of hoop stress of the meniscus. During UKA, care should be taken to avoid injury to the anteromedial capsular structure, as it will be too weak to resist bearing dislocation if it is injured.

Interestingly, we experienced one case in which the meniscus dislocated medially into the medial gutter. A sixty-four-year-old female patient who underwent mobile bearing Oxford UKA was admitted because of anterior bearing dislocation6 months after initial surgery. After changing the mobile bearing to a thicker one (from 4 mm to 6 mm), she returned to her daily life without any problems. However, 6 months later, she was again readmitted, due to re-dislocation of the bearing into the medial gutter (Figure 3). Anatomically, the medial gutter is narrow because of a tightened MCL and medial capsule, while the anterior and posterior compartments are larger. Therefore, the dislocated bearing is commonly seen in the anterior or posterior compartments on simple radiograph. In this case, an extremely loosened MCL and medial collateral structure could have caused mobile bearing dislocation. We observed that this situation can occur in other cases as well, although the dislocated bearing is more likely to shift to the anterior or posterior space.

Goodfellow et al. [8] identified the spontaneous elongation of ligaments as a risk factor for secondary dislocation [11]. They found that this does not seem to occur in the absence of impingement [8]. However, it can occur in the pre-operative period owing to meniscus extrusion. Prolonged meniscal extrusion, with elongation and damage to medial structures, can accumulate and increase the risk of dislocation after mobile bearing UKA. To prevent this complication, UKA with a fixed bearing, total knee arthroplasty, or careful dissection to avoid damage to medial structures, is recommended.

The drawbacks of the current study are, first, that it was not a prospective controlled study. Second, patients with good clinical outcomes in the control group did not receive the follow-up X-rays. Third, we did not have detailed information on complications in the medial structures, such as MCL edema or anteromedial capsular thickening. In 2011 and 2012, we took preoperative images with a low-resolution 0.5 T MRI, and the images were too blurry to distinguish medial structures in detail. Despite these limitations, this study is the first to evaluate pre-operative risk factors for bearing dislocation, and showed that meniscal extrusion over 3 mm is a contra-indication for Oxford mobile bearing UKA.

In conclusion, pre-operative meniscal extrusion of more than 3.16 mm is a significant risk factor for mobile bearing dislocation after Oxford mobile bearing UKA. For patients with meniscal extrusion, surgeons should be cautious in deciding to undertake Oxford mobile bearing UKA.

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