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Case report

Meniscal bearing dislocation while rolling over in sleep following Oxford medial unicompartmental knee arthroplasty

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ABSTRACT

Meniscal bearing dislocation while rolling over in sleep has never been reported in Oxford unicompartmental knee arthroplasty (UKA). This study reports two cases of meniscal bearing dislocation into the intercondylar ridge while rolling over in sleep. In the case of one patient, closed reduction of the bearing was performed, and the use of a knee brace was effective in preventing re-dislocation. In the second patient, closed reduction was possible; however, bearing dislocation was repeated. Therefore, revision surgery was performed by replacing the tibial component and using a thicker bearing. The common features in dislocation during rolling over while sleeping in both cases were dislocation into the intercondylar ridge, the combination of small femur and AA-size tibia components, and osteonecrosis. As determined by intraoperative testing, valgus position of the knee while rolling over in sleep could induce bearing dislocation into the intercondylar ridge.

Level of evidence: Retrospective case series, Level IV.

1. Introduction

Oxford medial unicompartmental knee arthroplasty (UKA) featuring a mobile bearing (Biomet Ltd., Swindon, United Kingdom) has shown favorable long-term results [1–3] and is gaining increasing popularity in Japan [4]. Moreover, the Oxford mobile bearing provides some advantages, including a low rate of bearing wear, favorable longevity, and minimal shear stress at the bone–implant interfaces. However, owing to its mobile mechanism, there is concern that bearing dislocation can occur in 0–5.3% of all cases, being more frequent in Asian than in Western populations [1,3,5–7]. The current institution has experienced three bearing dislocations in 223 knees, giving a rate of 1.3%. In a recent systematic review, bearing dislocation was found to be one of the main reasons for conversion from UKA to total knee arthroplasty [8]; therefore, it is crucial to identify and understand the dislocation mechanism in order to prevent dislocation.

Anterior and posterior bearing dislocations have been previously reported, and the possible underlying mechanisms include imbalance of the flexion–extension gap, impingement on the bearing, ligament damage, relatively frequent deep flexion positioning, and component malposition [9,10]. In contrast, bearing dislocation into the intercondylar ridge has rarely been reported, and its mechanism is unclear. Yoshida et al. reported bearing dislocation into the intercondylar ridge in two of 1251 cases; however, further details regarding treatment, injury patterns, and mechanism were not described [1]. Fujii et al. reported two cases of dislocation into the intercondylar

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ridge during deep flexion of the knee and hypothesized that malrotation of the femoral components may be a potential underlying cause [11]. The current study presents two cases after mobile bearing UKA where the bearing dislocated into the intercondylar ridge while rolling over in sleep. It is believed that this phenomenon has not been previously reported.

2. Case presentation

2.1. Case 1

Case 1 was that of a 67-year-old woman who had medial femoral condyle osteonecrosis of the left knee and underwent an Oxford medial UKA. Her pre-operative Knee Society Score was 51 points and the Knee Society Functional Score was 55 points [12]. The range of motion (ROM) of her left knee was 140° flexion and 0° extension. The UKA was performed as per the Oxford UKA surgical procedure using an image-free navigation system (The Stryker Navigation System). Some surgical methods specific to the tibial cut have been previously reported [13,14]. A small-sized femoral component and an AA-size tibial component with a five-millimeter thick meniscal bearing were implanted. Intraoperatively, it was confirmed that there was the same gap balance between knee flexion and extension, and the anterior cruciate ligament was well tensioned and covered with synovial membrane. There were no abnormal movements of the meniscal bearing and no signs of bearing dislocation. An experienced surgeon (HI) was the chief surgeon for all the procedures. At the two-year postoperative follow-up, the patient's Knee Society Score was 95 points and the Knee Society Functional Score was 100 points. The ROM of her left knee was 140° flexion and 0° extension. She did not report experiencing knee instability in daily life, and stability of the cruciate and collateral ligaments was maintained throughout the experimental period.

At the three-year postoperative follow-up, the patient reported experiencing left knee pain when she rolled over in sleep and felt discomfort in the left knee at rest. The ROM was restricted to 120° flexion and 0° extension; however, she was able to walk independently. The meniscal bearing was dislocated into the intercondylar ridge, as shown by radiography images, and there was no aseptic loosening of the components (Figure 1). Closed reduction of the bearing was performed by medializing the femur against the tibia under fluoroscopy. Three months after the first dislocation, the patient reported discomfort in the knee while rolling over in sleep again. However, no bearing dislocation was observed on radiographic examination. Because the symptoms and situation were very similar to that of the first dislocation it was recommended that she wear a knee brace while sleeping to prevent bearing dislocation while rolling over in sleep. After she started wearing a knee brace she did not experience discomfort in her knee or bearing dislocation in sleep. Eighteen months after the bearing dislocation, at the latest follow-up, her Knee Society Score was 95 points, and the Knee Society Functional Score was 100 points. The ROM of her left knee was 140° flexion and 0° extension, with no repeat of bearing dislocation.

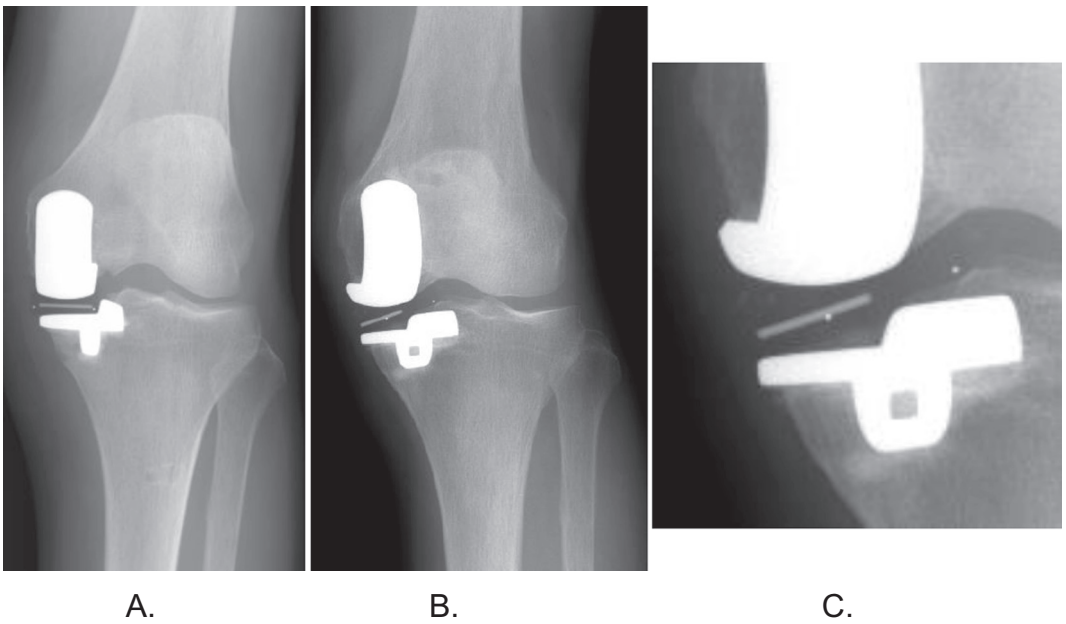

Figure 1. Case 1 radiographs. (A) Postoperative plain radiographs of the left knee (anteroposterior view); (B) plain radiographs when the bearing dislocated into the intercondylar ridge; (C) enlarged radiographs of the bearing with bearing dislocation into the intercondylar ridge.

2.2. Case 2

The second case was that of a 51-year-old woman with medial tibial plateau osteonecrosis of the right knee who underwent Oxford medial UKA. Her pre-operative Knee Society Score was 50 points, and the Knee Society Functional Score was 70 points. The ROM of her left knee was 150° flexion and 0° extension. The surgical technique was the same as that in Case 1. A small-sized femoral component and an AA-size tibial component with a three-millimeter thick meniscal bearing were implanted. Intra-operatively, it was confirmed that there was the same gap balance between knee flexion and extension, and the anterior cruciate ligament was well tensioned and covered with synovial membrane. There was no abnormal movement of the meniscal bearing or signs of bearing dislocation. An experienced surgeon (HI) was the chief surgeon for all procedures.

At the two-week postoperative follow-up, the patient was able to walk freely without a T-cane, and the ROM of her right knee was 140° flexion and 0° extension. However, at 15 days after the UKA she experienced right knee pain when she rolled over in her sleep, and the radiograph showed that the meniscal bearing was dislocated into the intercondylar ridge (Figure 2). Closed re-position of the bearing was performed by medializing the femur against the tibia under fluoroscopy, in the same way as in Case 1. After the first dislocation, the patient experienced three more bearing dislocations into the intercondylar ridge, which required closed reduction two weeks after the first dislocation. A knee brace was ineffective in preventing bearing re-dislocation. Therefore, it was planned to perform surgical intervention to prevent re-dislocation.

During revision surgery, the bearing was easily dislocated into the intercondylar ridge, riding over the lateral wall of the tibial component in valgus and with slight flexion of the knee (Figure 3). Knee extension was evaluated at 20° knee flexion, and knee flexion was evaluated at 110° knee flexion, according to Oxford's recommendation. A three-millimeter thickness was the closest to natural tension and the gap between knee flexion and extension was the same; however, in order to prevent dislocation, the bearing thickness was first changed from three millimeters to five millimeters. Consequently, the dislocation tendency did not improve in the valgus and slight flexion of the knee. Therefore, the tibial component was removed and the vertical cut was re-performed to move the tibial tray more laterally, changing the size from AA to A size, so that the bearing did not move over the lateral wall. Additionally, the horizontal cut had to be increased by about four millimeters to expose the tibial cancellous bone surface after the removal procedure in order to replace the component. The bearing thickness closest to natural tension was seven millimeters and the gap between knee flexion and extension was the same; however, the bearing elevated off the tibial tray at seven millimeters. Consequently, a bearing thickness of eight millimeters was used to prevent dislocation, with the aforementioned maneuver.

One year after revision UKA, at the latest follow-up, the patient's knee was pain free, she could walk without a T-cane, and had a ROM of 0° extension and 140° flexion. Her Knee Society Score was 95 points, the Knee Society function score was 100 points, and she had no bearing re-dislocation.

Both patients provided their consent for publication of their data.

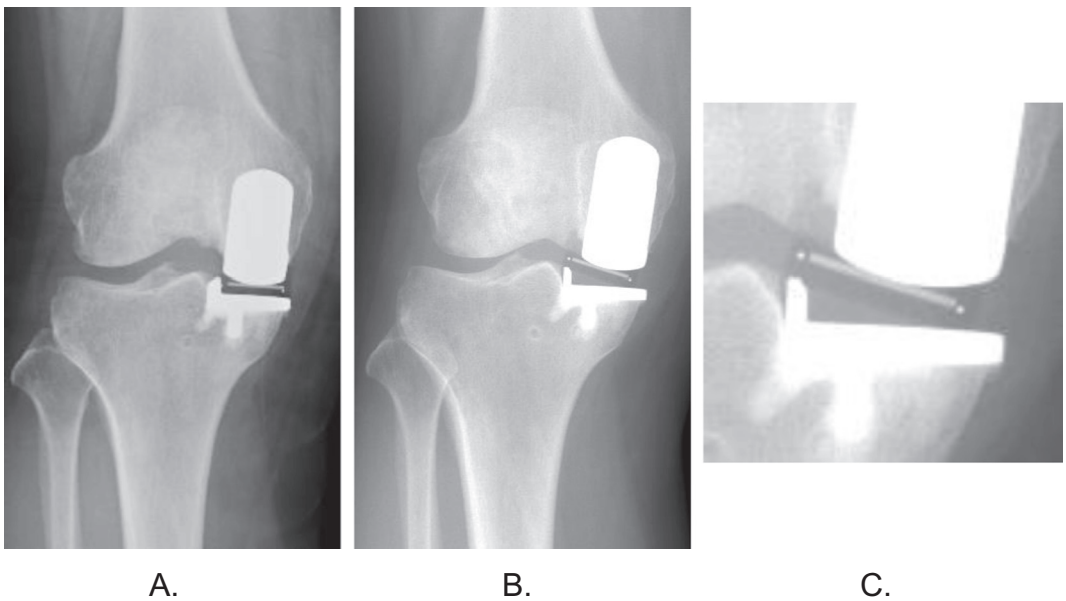

Figure 2. Case 2 radiographs. (A) Postoperative plain radiographs of the right knee (anteroposterior view); (B) plain radiographs when the bearing dislocated into the intercondylar ridge; (C) enlarged radiographs of the bearing with bearing dislocation into the intercondylar ridge.

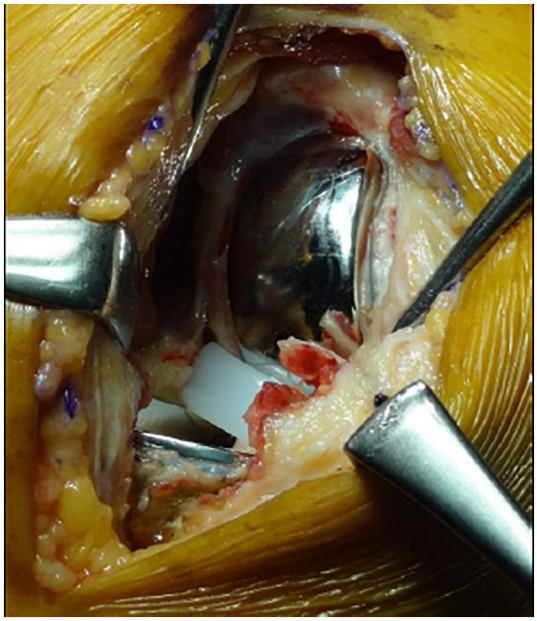

Figure 3. Intraoperative findings in Case 2. The bearing was easily dislocated into the intercondylar ridge.

3. Discussion

This study reports two rare cases of bearing dislocation into the intercondylar ridge while rolling over in sleep, and discusses their mechanisms. It is believed that meniscal bearing dislocation while rolling over in sleep has never been reported after an Oxford UKA. Few reports have described bearing dislocation into the intercondylar ridge; however, its mechanism remains unclear.

Some previous reports have mentioned the risk factors for bearing dislocation in Oxford UKA. Bozkurt et al. ensured proper removal of the posterior bone spurs to prevent dislocation from impingement of the bearing on the posterior bone spurs of the medial femoral condyle in a case of anterior dislocation [15]. Lee et al. reported 17 cases of anterior and posterior dislocation in UKA, and they found reduction in posterior tibial inclination to be the underlying cause. They recommended preventing a decrease in the degree of posterior inclination as a precautionary measure [16]. Goodfellow et al. reported imbalance of the flexion–extension gap and intraoperative damage to ligaments as risk factors of bearing dislocation [9]. However, none of the above-mentioned dislocation factors was present in the current two cases.

The common features in the current two cases of dislocation during rolling over in sleep were a dislocation into the intercondylar ridge, osteonecrosis, and a combination of small femur AA size with tibia components. Regarding dislocation into the intercondylar ridge, Fujii et al. discussed two cases of dislocation into the intercondylar ridge and proposed malrotation of the femoral components as the underlying cause [11]. However, neither of the current cases showed issues with rotation of the femoral component (the femoral component was externally rotated 0° and three degrees in Cases 1 and 2, respectively, and shown to be perpendicular to

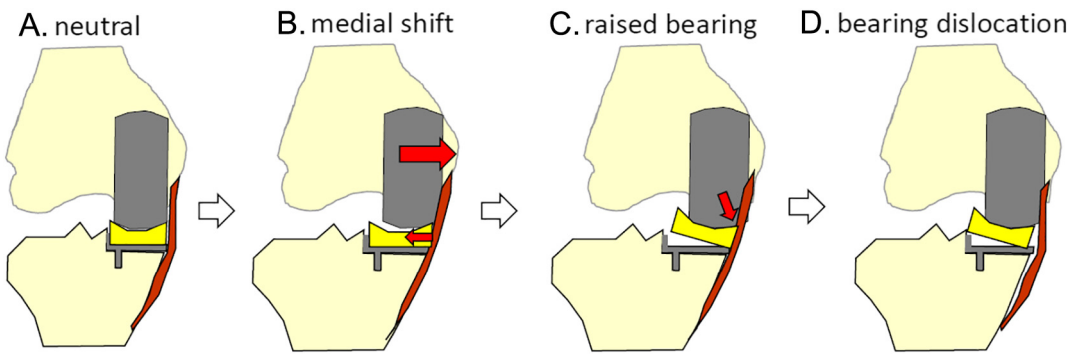

Figure 4. Schematic demonstration of the possible mechanisms. (A) Neutral position. (B) Medial stress applied to the femur during rollover. The tight medial collateral ligament (MCL) constrained the bearing from moving medially. (C) The medially shifted femoral component rode over the medial edge of the bearing that forced downward pressure, leading the lateral side of the bearing to be elevated off the tibial tray. (D) Surpassing the lateral wall of the tibial component and being dislocated into the intercondylar ridge.

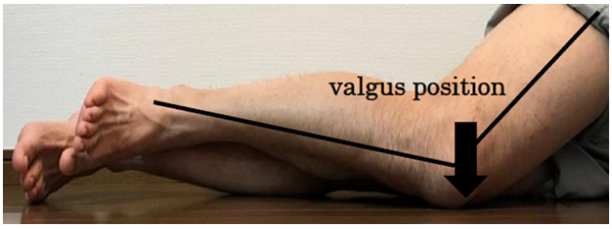

Figure 5. Image demonstration of rolling over during sleep. The limb position while rolling over during sleep can result in a relative degree of knee valgus. The black arrow shows the force medializing the femur.

the surgical epicondylar axis by postoperative computed tomography; it was within 10° in varus/valgus position on the postoperative antero-posterior plain radiographs) and this largely ruled out malrotation as the dislocation cause. None of the other common features between the two cases have been previously reported to be associated with bearing dislocations.

Intraoperative replay of the bearing dislocation at revision surgery helped to understand the mechanism underlying dislocation while rolling over in sleep. The following potential mechanism has been suggested: First, the force that medialized the femur was generated in the knee valgus position during rollover. However, a tight medial collateral ligament (MCL) constrained the bearing from moving medially (Figure 4A and B). The medially shifted femoral component rode over the medial edge of the bearing that forced downward pressure, causing the lateral side of the bearing to be elevated off the tibial tray (Figure 4C). Finally, the bearing surpassed the lateral wall of the tibial component and dislocated into the intercondylar ridge (Figure 4D).

Muscle tone while awake limits the degree of valgus positioning of the limb; however, relaxation of this muscle tone while asleep could allow an excessive degree of valgus deformity. The gravity force that medialized the femur was generated in the valgus knee position (Figure 5), and the force on the femur could be crucial for the mechanism of the bearing dislocation. The cessation of dislocation after replacing an A-size tibial component also suggests that dislocation could have been prevented if space existed between the bearing and the lateral wall of the tibial component when the bearing was raised. In other words, it was easy for the bearing to be dislocated over the lateral wall using AA-sized tibial components because the elevated bearing and the lateral wall were in close proximity. The small femur–AA tibia combination in both cases could also have contributed to the dislocation. The onset of bearing dislocation in the postoperative period was different between the two cases, and the difference was due to the tendency of the dislocation. In the second case, the dislocation could be very easily duplicated intraoperatively; therefore, dislocation happened in the early postoperative period. On the contrary, in the first case, the bearing dislocation was not repeated and the bearing could not be easily dislocated under fluoroscopy; therefore, the bearing dislocated only in the late postoperative period.

In these two cases of bearing dislocation, a closed reduction was possible. Moreover, there was no re-dislocation in one case. In the other case, closed reduction was possible; however, revision surgery was necessary for repeated dislocations. Cool et al. also stated that closed reduction of the bearing was effective for anterior bearing dislocation; however, surgical intervention was required in the posterior bearing dislocation because the bearing dropped to the tibial posterior space [17]. Furthermore, Yoshida et al. reported that revision surgery, including bearing replacement, is necessary in case of MCL instability [1]. Fujii et al. performed immediate surgical intervention for both their patients with dislocation into the intercondylar ridge because they speculated that chronic ligamentous laxity potentially existed, and malrotation of the femoral component also attributed to dislocation in both cases [11]. Further, in these two cases no MCL instability was observed, allowing non-invasive reduction of the bearing. However, revision was required in one case because of the risk of repeat dislocation. In the case of bearing dislocation into the intercondylar ridge, non-invasive reduction should first be attempted following initial dislocation in cases where there is a healthy MCL. If dislocation recurs despite restriction of the limb position at night by using a knee brace or other measures, surgical intervention, such as switching to a thicker bearing and repositioning of the tibial component, may be required.

Following this experience with the two cases described in this report, valgus and mild knee flexion are now intraoperatively reproduced where the bearing could be dislocated into the intercondylar ridge. The knee is forced into the valgus position, and the femur applies a stress on the medial aspect of the tibial bearing causing elevation of the lateral edge of the bearing to conduct a 'rolling over in sleep test (ROS test)' to confirm if a bearing has a tendency to dislocate into the intercondylar ridge. It is speculated that the measures including tibial repositioning and switching to a thicker bearing are necessary when the bearings have a tendency to dislocate into the intercondylar ridge in the ROS test. However, thus far, no patient has tested positive for such a tendency in these intraoperative tests, and no patients have presented with bearing dislocation into the intercondylar ridge postoperatively since this report. Further studies that involve a larger sample size and longer follow-up period are required. Additionally, this work could be better substantiated by biomechanical or cadaver testing in the future.

Conflict of interest

The authors declare that their institute received donations for research from ZimmerBiomet.

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