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# *CORR* Insights®: Bearing Dislocation and Progression of Osteoarthritis After Mobile-bearing Unicompartmental Knee Arthroplasty Vary Between Asian and Western Patients: A Meta-analysis

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## Where Are We Now?

Unicondlyar knee arthroplasty (UKA) implants are generally nonconstrained, allowing for more-normal rollback and rotation of the knee during knee flexion. Mobile-bearing UKA implants provide a fully conforming bearing surface between the femoral component and tibial insert that allows AP movement and rotation between the tibial insert and tibial baseplate. By contrast, fixed-bearing UKA implants permit AP and rotational movement between the femoral component and relatively flat tibial bearing surface. The fully conforming nature of mobile-bearing UKA implants results in greater ultra-high-molecular-weight polyethylene (UHMWPE) contact area and lower contact stresses than fixed-bearing UKA, which has been associated with low UHMWPE wear in vivo [6, 12]. And although mobile-bearing UKAs have demonstrated excellent long-term survivorship [10], they also have a risk of bearing dislocation, which can result in revision surgery [10, 17].

Prior to the mid-1990s, UHMWPE implants were sterilized by gamma irradiation in air, resulting in oxidative degradation and decreased wear resistance of the polymer [14], and during this time, studies reported excellent long-term survivorship and low wear for mobile-bearing UKA implants [4, 12]. But after gamma irradiation in air sterilization was abandoned as a solution to polyethylene oxidation [9], alternative sterilization methods emerged, including ethylene oxide, gas plasma, and gamma irradiation in an inert atmosphere. Crosslinking, which is currently used in most hip and many knee implants [15], can reduce UHMWPE wear. The benefit of mobile-bearing UKA in reducing UHMWPE wear compared to fixed-bearing implants may be less important as improvements have been developed in UHMWPE sterilization and processing.

Mobile-bearing TKAs are also associated with lower bone-implant interface stresses compared to relatively conforming fixed-bearing implants [2]. Cementless mobile-bearing UKA has been used successfully, which may be related to the reduced bone-implant interface stresses of these implants [16]. But since most of the currently available fixed-bearing UKA implants have relatively flat nonconforming surfaces, we may not find clinically relevant differences in interface stresses between the two implant types. Indeed, both mobile- and fixed-bearing UKA implants include gap balancing, computer navigation, and robotics, and currently available implant materials include more wear-resistant UHMWPE and abrasive-resistant counterface surfaces than what has been available in the past.

In the current study, Ro and colleagues [13] demonstrated that the

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causes for revision of mobile- and fixed-bearing UKA differ between Asian and Western patient populations. The authors note that Western patients have a higher risk of revision because of lateral compartment osteoarthritis (OA) progression than do Asian patients after medial UKA, perhaps suggesting that patient selection criteria may be more important for Western than Asian patients in deciding between UKA and TKA. The authors also suggest that the greater flexion activities in Asian patients may result in a greater risk of bearing dislocation. In this context, patients with greater knee flexion activities may have a more-favorable risk-benefit ratio with use of fixed- rather than mobile-bearing UKA. Lateral mobile-bearing UKA implants have been shown to have a relatively high risk of dislocation in clinical studies, which is consistent with the greater AP excursion and rollback in the lateral compared to the medial tibiofemoral compartment and supports the findings in the current study that more knee motion is associated with greater risk of bearing dislocation [17].

## Where Do We Need To Go?

When gamma irradiated in air UHMWPE was used in total joint arthroplasty, highly conforming mobile bearings offered an advantage compared to fixed bearings in reducing risk of delamination wear-related failures [8]. However, delamination wear has been eliminated by use of non-gamma in air sterilization of UHMWPE and wear is further reduced with use of highly crosslinked UHMWPE [9, 11]. To predict the relative safety and efficacy associated with currently available mobile- and fixed-bearing UKA implants, researchers need to assess how improved surgical techniques and implant materials affect mechanical durability and wear-related failure mechanism of these implants in vivo.

Patients considering surgical treatment for medial OA usually want to understand the expected functional results and longevity of reconstructive surgery. UKA has been found to result in more normal kinematics and greater knee flexion than TKA, while TKA results in greater long-term survivorship [1, 3, 7]. The authors of the current study showed that mobile-bearing UKA requires revision in Asian patients from dislocation, which is usually an early failure mechanism, while the need for revision surgery in Western patients occurs from progression of lateral compartment OA, considered a late failure mechanism [13]. The findings suggest that fixed-bearing UKA would help eliminate the risk of dislocation for Asian patients. However, the results do not indicate whether fixed- or mobile-bearing UKA would provide greater longevity in Western patients since the need for revision surgery observed in the current study for this patient population was related more to lateral compartment progression OA than failure of the UKA implant. Future clinical studies should examine whether Western patients would experience greater survivorship after either fixed or mobile bearing UKA using currently available implant materials and surgical techniques for treating isolated medial knee OA of the knee.

## How Do We Get There?

In vitro studies could compare the relative benefits of mobile-bearing UKA implants to fixed-bearing implants using currently available implant materials. Examining the risk of bearing dislocation likely requires clinical studies. Wear-simulator studies [5, 11] indicate that mobile-bearing UKA may not reduce wear as well as currently available fixed-bearing designs. Using finite element analysis and mechanical testing, we could compare mobile-bearing TKA to fixed-bearing UKA on UHMWPE wear, implant interface stresses, and material stresses with currently available implants.

We generally assume that Asian patients are involved in more floor-based activities than Western patients, and thus, require greater active and passive knee flexion. However, the specific differences in biomechanical demands on the knee joint between the two patient populations has not been well established. Further analyses using gait study methods during functional activities could help quantify the effect of lifestyle on knee biomechanics between the two groups.

The risk of bearing dislocation has been shown to be higher for lateral UKA and in Asian patients with medial UKA [13, 17]. Clinical studies that correlate active and passive ROM with relative risk of revision due to dislocation would be useful to determine whether mobile-bearing UKA patients with increased knee flexion or knee flexion activities have a greater risk of bearing dislocation. The combination of both in vitro and in vivo studies with clearly-defined patient characteristics would likely better define the safety and efficacy of mobile-bearing UKA using currently available implant materials and surgical techniques.

## *References*

1. Argenson JNA, Komistek RD, Aubaniac JM, Dennis DA, Northcut EJ, Anderson DT, Agostini S. In vivo determination of knee kinematics for subjects implanted



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with a unicompartmental arthroplasty. *J Arthroplasty*. 2002;17:1049–1054.

2. Chapman-Sheath PJ, Bruce WJM, Chung WK, Morberg P, Gillies RM, Walsh WR. In vitro assessment of proximal polyethylene contact surface areas and stresses in mobile bearing knees. *Med Eng Phys*. 2003;25:437–443.
3. Goh GSH, Bin Abd Razak HR, Tay DKJ, Chia SL, Lo NN, Yeo SJ. Unicompartmental knee arthroplasty achieves greater flexion with no difference in functional outcome, quality of life, and satisfaction vs total knee arthroplasty in patients younger than 55 years. A propensity score matched cohort analysis. *J Arthroplasty*. 2018;33:355–361.
4. Jackson WFM, Berend KR, Spruijt S. 40 years of the Oxford knee. *Bone Joint J*. 2016;98:1–2.
5. Kretzer JP, Jakubowitz E, Reinders J, Lietz E, Moradi B, Hofmann K, Sonntag R. Wear analysis of unicondylar mobile bearing and fixed bearing knee systems: A knee simulator study. *Acta Biomater*. 2011;7:710–715.
6. Kwon OR, Kang KT, Son J, Kwon SK, Jo SB, Suh DS, Choi YJ, Kim HJ, Koh YG. Biomechanical comparison of fixed- and mobile-bearing for noncompartmental knee arthroplasty using finite element analysis. *J Orthop Res*. 2014;32;338–345.
7. Labek G, Thaler M, Janda W, Agreiter M, Stockl B. Revision rates after total joint replacement: cumulative results from worldwide joint register datasets. *J Bone Joint Surg Br*. 2011;93:293e7.
8. Manson TT, Kelly NH, Lipman JD, Wright TM, Westrich GH. Unicondylar knee retrieval analysis. *J Arthroplasty*. 2010;25:108–111.
9. Medel FJ, Kurtz SM, Hozack WJ, MD, Parvizi J, Purtill JJ, Sharkey PF, MacDonald D, Kraay MJ, Goldberg V, Rimnac CM. Gamma inert sterilization: A solution to polyethylene oxidation? *J Bone Joint Surg Am*. 2009;91:839–849.
10. Mohammad HR, Strickland L, Hamilton TW, Murray DW. Long-term outcomes of over 8,000 medial Oxford phase 3 unicompartmental knees – A systematic review. *Acta Orthop*. 2017;89:101–107.
11. Netter J, Hermida JC, D'Alessio J, Kester M, D'Lima DD. Effect of polyethylene crosslinking and bearing design on wear of unicompartmental arthroplasty. *J Arthroplasty*. 2015;30:1430–1433.
12. Price AJ, Short A, Kellett C, Beard D, Gill H, Pandit H, Dodd CAF, Murray DW. Ten-year in vivo wear measurement of a fully congruent mobile bearing unicompartmental knee arthroplasty. *J Bone Joint Surgery Br*. 2005;87; 1493–1497.
13. Ro K-H, Heo J-W, Lee D-H. Bearing dislocation and progression of osteoarthritis after mobile-bearing unicompartmental knee arthroplasty vary between Asian and Western patients: A meta-analysis. *Clin Orthop Relat Res*. [Published online ahead of print]. DOI: 10.1007/s11999.0000000000000205.
14. Sutula L C, Collier JP, Saum KA, Currier BH, Currier JH, Sanford WM, Mayor MB, Wooding RE, Sperling DK, Williams IR. The Otto Aufranc Award: Impact of gamma sterilization on clinical performance of polyethylene in the hip. *Clin Orthop Relat Res*. 1995;319:28–40.
15. Tsukamoto R, Chen S, Asano T, Ogino M, Shoji H, Nakamura T, Clarke IC. Improved wear performance with cross-linked UHMWPE and zirconia implants in knee simulation. *Acta Orthop*. 2006; 77:505–511.
16. van der List JP, Sheng DL, Kleeblad LK, Chawla H, Pearle AD. Outcomes of cementless unicompartmental and total knee arthroplasty: A systematic review. *The Knee*. 2017;24:497–507.
17. Walker T, Zahn N, Bruckner T, Streit MR, Mohr G, Aldinger PR, Clarius M, Gotterbarm T. Mid-term results of lateral unicondylar mobile bearing knee arthroplasty: A multicentre study of 363 cases. *Bone Joint J*. 2018;100;42–49.

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