Arthroplasty Today 27 (2024) 101321

Contents lists available at ScienceDirect

Arthroplasty Today

journal homepage: http://www.arthroplastytoday.org/

Special Issue: Highlights from the Young Arthroplasty Group (YAG) of AAHKS. Edited by Anna A.R.Cohen-Rosenblum

Catastrophic Femoral Component Failure of a Unicompartmental Knee Arthroplasty

Kenneth Ierardi, DO*, Matthew Hammond, DO, William C. Searls, DO, Kenneth Scott, DO

Department of Orthopedic Surgery, Henry Ford Macomb Hospital, Clinton Township, MI, USA

ARTICLE INFO

Article history:
Received 6 September 2023
Received in revised form
21 December 2023
Accepted 21 January 2024
Available online 19 February 2024

Keywords:
Unicompartmental knee arthroplasty
Aseptic loosening
Revision knee arthroplasty

ABSTRACT

We report a case of previously undescribed medial unicompartmental knee arthroplasty failure due to femoral component implant fracture. The patient experienced sudden pain and locking while ambulating 8 years postoperatively. Radiographs revealed catastrophic femoral component failure with a transverse break through the metal. The patient underwent revision to total knee arthroplasty. At 1-year follow-up, the patient had no pain and a range of motion of 130 degrees. Particular attention should be paid to obtaining adequate femoral component posterior flange fixation during unicompartmental knee arthroplasty. Patient education regarding maintaining a healthy weight is crucial to preventing this complication.

Introduction

Unicompartmental knee arthroplasty (UKA) is a reliable alternative to total knee arthroplasty (TKA) in properly selected patients [1-4]. Knee osteoarthritis is projected to cause an exponential increase in the number of arthroplasty procedures performed throughout the next few decades [5]. UKA currently accounts for 4% of all knee arthroplasty procedures performed in the United States [6]. The utilization of UKA varies globally, with the Swedish Arthroplasty Register reporting that 12.8% of knee arthroplasty procedures are UKAs, and the Australian registry reporting a 7.4% UKA rate [7,8]. UKA has demonstrated some distinct advantages over TKA including improved postoperative range of motion, proprioception, bone preservation, faster recovery, and improved patient satisfaction [9-11]. Successful medial UKA is ideally performed in patients with isolated medial compartment osteoarthritis with stable ligamentous examination, correctable deformity, and preserved range of motion with <15-degree flexion contracture [12]. UKA is a technically demanding procedure with current 10-year survivorship ranging from 85% to 98% and higher surgeon volumes correlating with a lower risk of revision surgery [13-16]. UKA complications include aseptic loosening, bearing dislocation, polyethylene wear, tibial fractures, osteoarthritis progression, infection, and unexplained pain. Avoiding complications requires proper patient selection and positioning of components.

We report a unique case of failed medial UKA with accelerated polyethylene wear and catastrophic failure of the femoral component involving implant fracture. The patient provided informed consent for publication of this data and images. This report was deemed exempt by our institutional review board.

Case history

The case is of a 54-year-old male who received a primary cemented left medial Oxford UKA in 2014 at our institution. He initially presented with isolated medial knee pain with activity. Radiographs demonstrated moderate medial compartment arthritis with minimal coronal plane deformity (Fig. 1). Examination revealed stable ligaments with a correctable deformity. Magnetic resonance imaging of his knee demonstrated isolated medial compartment chondromalacia with bone edema. His medical history was only significant for hypertension, and he had no prior surgical history. His body mass index (BMI) was 30, and he worked as a truck driver. He failed conservative management with intra-articular steroid injections, viscosupplementation, nonsteroidal anti-inflammatory drugs, and a medial unloader brace. The

* Corresponding author. Department of Orthopedic Surgery, Henry Ford Macomb Hospital, 15855 19 Mile Road, Clinton Township, MI 48038, USA. Tel.: +1 978 778 8067.
E-mail address: kmierardi@gmail.com

https://doi.org/10.1016/j.artd.2024.101321

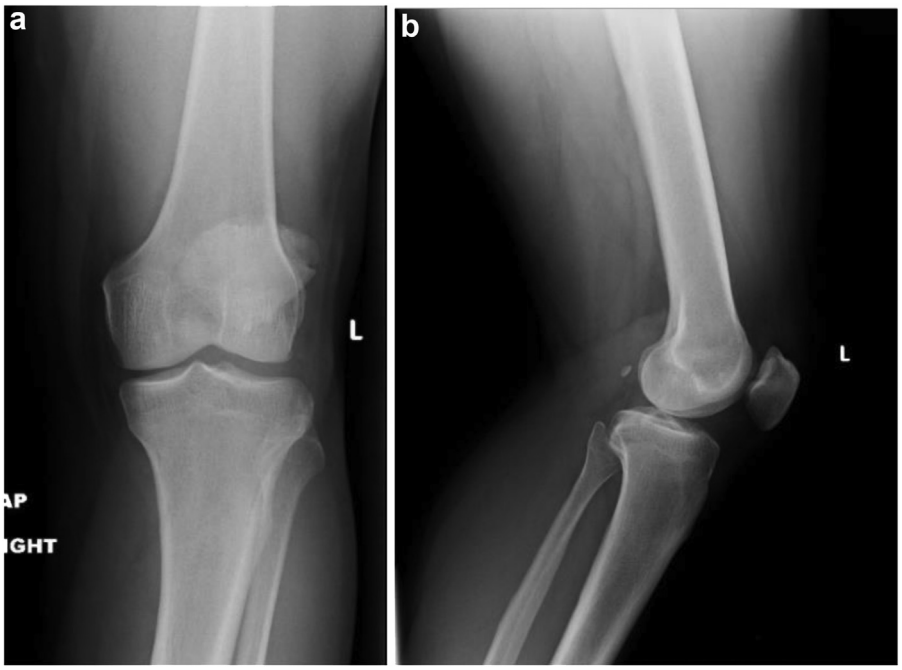

Figure 1. Initial preoperative anteroposterior (a) and lateral (b) weightbearing radiographs of the left knee.

decision was made to undergo medial UKA given his examination, symptoms, failed conservative management, and isolated medial compartment disease on magnetic resonance imaging. A medial approach was performed, and components appeared well fixed with proper alignment on immediate postoperative anteroposterior (AP) and lateral radiographs (Fig. 2a and b). He had no postoperative complications and returned to his activities without pain.

At 6-year follow-up, he described progressive onset of left knee pain. Weightbearing AP and lateral radiographs of the left knee demonstrated a radiolucency about the medial posterior femoral condyle without additional radiographic evidence of implant loosening (Fig. 3a and b). On examination, the patient's pain originated over the lateral and patellofemoral compartments with a stable ligamentous examination. His range of motion was 0 to 130 degrees. His pain was therefore thought to be due to progression of osteoarthritis. His BMI had increased to 36 from 30 at his index procedure. In shared decision-making with the patient, it was decided to continue conservative management at this time, and he was given a viscosupplementation injection and physical therapy with significant improvement in his symptoms. While viscosupplementation following UKA with progression of osteoarthritis has not been well studied, the patient wished to pursue this, and it was felt to be a reasonable option.

At 8-year follow-up, the patient called the office to request an appointment after he felt a painful crack and locking event in his

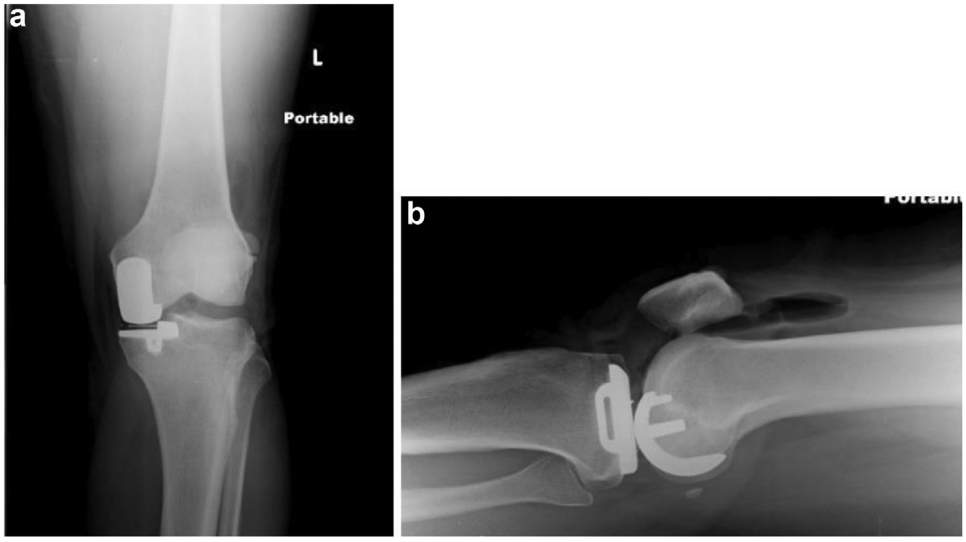

Figure 2. Immediate postoperative anteroposterior (a) and lateral (b) non-weightbearing radiographs of the left knee demonstrating a well-positioned medial UKA.

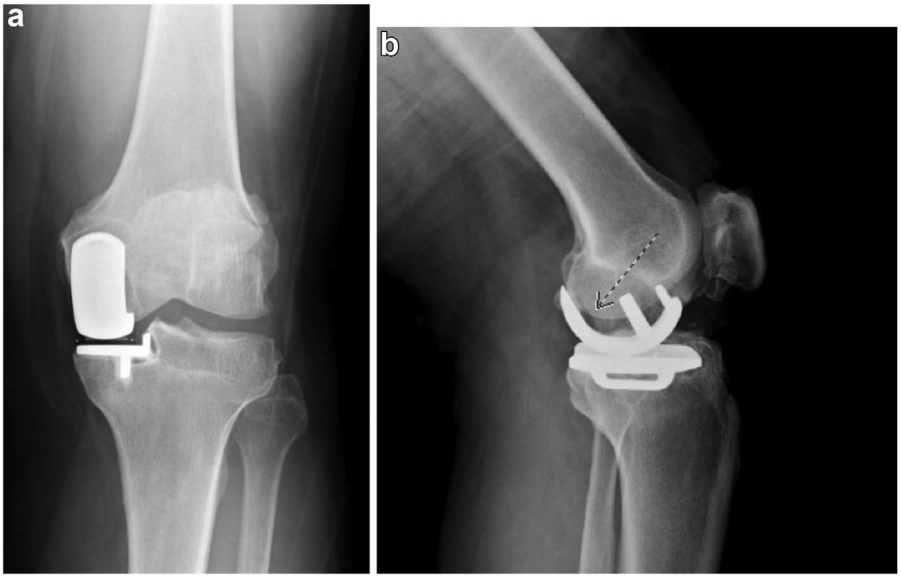

Figure 3. Anteroposterior (a) and lateral (b) weightbearing radiographs demonstrating radiolucency along the medial posterior femoral condyle implant-cement interface (arrow) with progression of patellofemoral and lateral compartment osteoarthritis.

left knee while walking down stairs. He was unable to ambulate secondary to the severe pain in his left knee. AP and lateral radiographs demonstrated a fracture of the femoral component with posterior displacement of the posterior femoral flange (Fig. 4a and b). His BMI had also now increased to 38. A workup for infection revealed normal erythrocyte sedimentation rate and C-reactive protein levels. The patient was admitted with plan to undergo conversion of the failed UKA to TKA.

A medial parapatellar approach was utilized after inflation of a tourniquet. A synovectomy was performed after metal discoloration was seen in the synovial tissue. Fluid and tissue cultures were sent and had no growth. The UKA femoral component demonstrated a complete transverse coronal split in the metal just posterior to the fixation post (Fig. 5a-c). The anterior flange remained well fixed to the medial femoral condyle while the posterior flange was completely loose and displaced posteriorly. The polyethylene liner was cracked and demonstrated complete central wear down to the tibial component baseplate (Fig. 6a and b). The tibial component baseplate remained well fixed. Grade 3 and 4 chondral defects were noted in the lateral and patellofemoral compartments. The components were removed with osteotomes and a standard saw at the cement-component interface with minimal bone loss on both the tibial and femoral sides. The knee was copiously irrigated with multiple solutions and saline. Intramedullary guides were used to make distal femoral and tibial cuts. No navigation or technology was used in this case. After cuts were made, the cut surfaces demonstrated healthy-appearing bone without any significant defects. The decision was made to place a stem in the tibia in order to prevent any future loosening given the patient's BMI, prior aseptic loosening history, and high-demand activity. This was not deemed necessary on the femur as the cut surfaces were pristine and great balance was achieved with cruciate retaining trial implants in place. A cemented Zimmer Biomet Persona cruciate-retaining TKA was utilized with a size-10 femoral component and

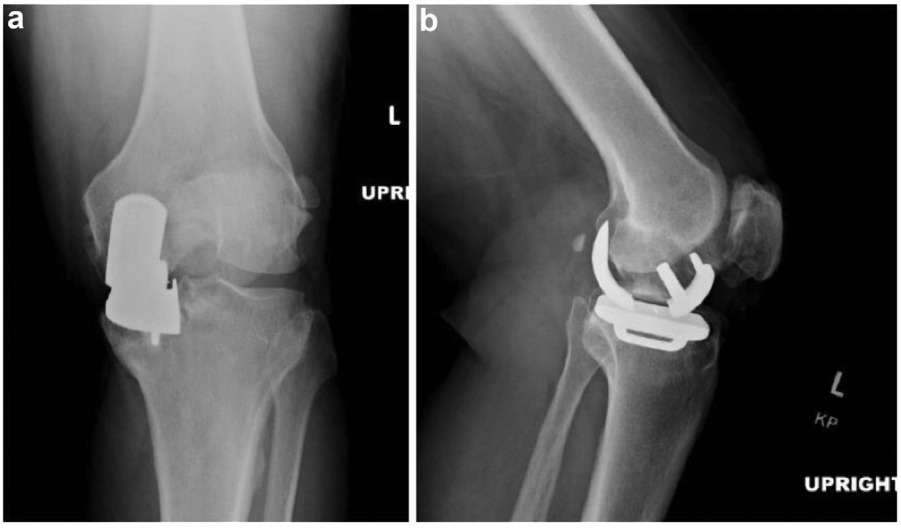

Figure 4. Anteroposterior (a) and lateral (b) non-weightbearing radiographs at 8-year follow-up demonstrating a fracture of the femoral component with posterior displacement of the posterior flange.

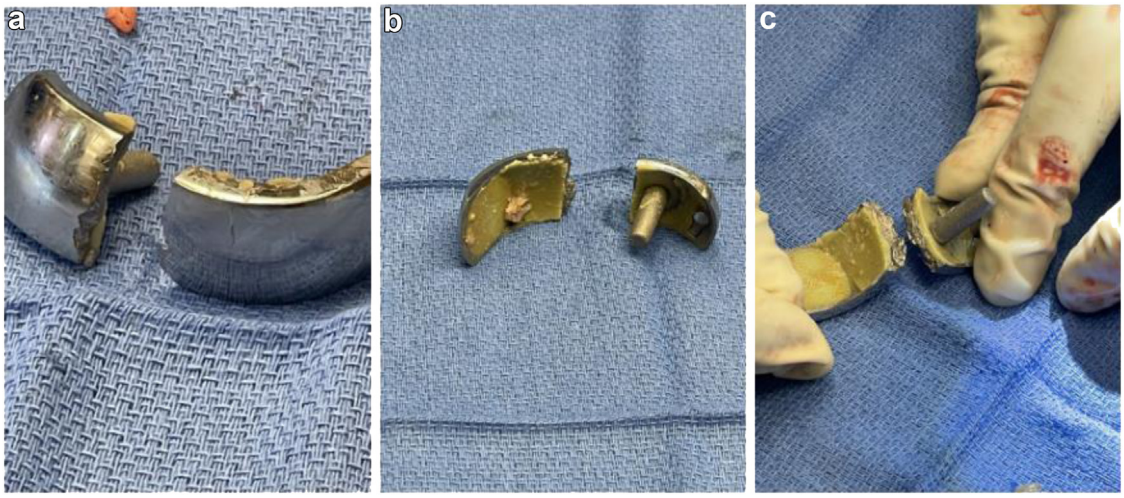

Figure 5. Intraoperative images (a-c) of the broken femoral component with coronal plane fracture immediately posterior to the fixation post.

size-G tibial component. Two grams of vancomycin was added to the cement. A 3-mm offset 12 × 135-mm press fit tibial stem obtained excellent fixation. The knee was well balanced in flexion and extension with a 10-mm medial congruent polyethylene. The patella was noted to have grade 3 chondral changes, and in order to optimize patellar tracking and prevent any need for future revision, the patella was resurfaced with a press-fit 38-mm patellar component. Press-fit fixation was chosen as this is the surgeon's preference, and the patient had healthy native bone which had not previously been instrumented. Radiographs postoperatively revealed excellent position of the components (Fig. 7a and b). The patient underwent an uncomplicated postoperative course. His pain resolved, and at 1-year follow-up, he was doing well with knee range of motion of 0 to 130 degrees.

Discussion

To our knowledge, this catastrophic failure mechanism of a unicompartmental femoral component and accelerated polyethylene wear has not been previously reported. UKA aseptic loosening is more often reported with the tibial component [17,18]. This is thought to arise from a deep sagittal saw cut when preparing the tibia [19]. Femoral aseptic loosening with UKA does occur but is believed to be a less-common failure mechanism [20,21]. While the Oxford UKA has shown excellent outcomes, it has been demonstrated that femoral component loosening incidence is 0% to 2.1% [15,22,23].

Previous case reports involving UKA femoral aseptic loosening have demonstrated complete loosening with displacement of the component, but none have reported a fatigue fracture of the component [24]. Bouché and Ehkirch recently described 2 cases of femoral loosening with a 180-degree spin of the femoral component; however, this occurred in lateral compartment UKAs [25]. In our case, the femoral component anterior flange remained well fixed to the femur with isolated posterior femoral loosening and displacement. Poor initial fixation of the posterior flange of the femoral component likely led to cantilever bending of the femoral component over time. This caused accelerated polyethylene wear,

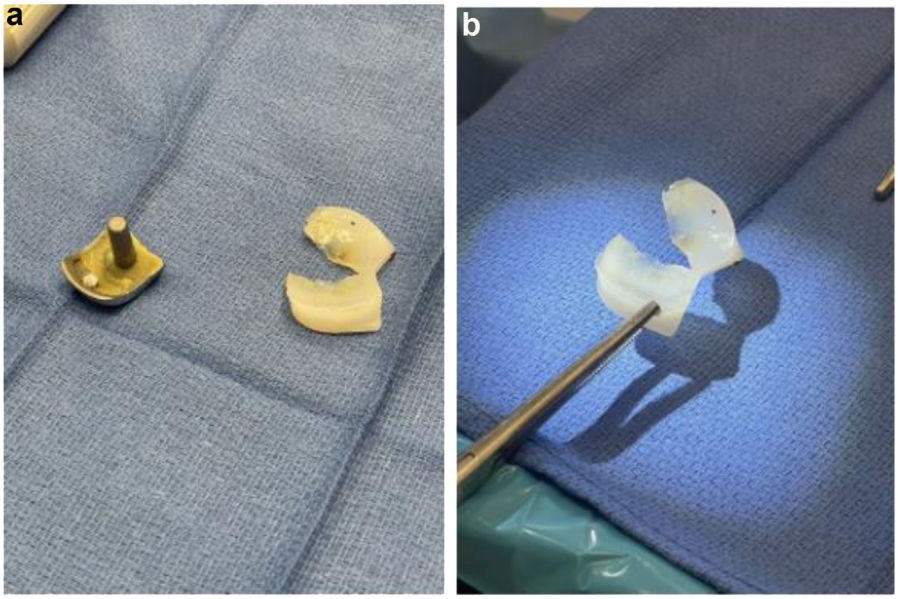

Figure 6. Intraoperative images (a) and (b) of the polyethylene component demonstrating catastrophic central wear with fatigue crack.

Figure 7. Postoperative anteroposterior (a) and lateral (b) radiographs following conversion of failed UKA to cemented cruciate-retaining total knee arthroplasty with a tibial stem and press-fit patellar component.

increasing the contact stresses on the femur over time, and ultimately leading to fatigue failure of the component at its lever point just posterior to the fixation post. Initial fixation of the posterior femoral condyle may have been due to a pitfall with the posterior femoral saw cut being angled too far anteriorly [26-28]. This likely led to the posterior flange having poor support with an inadequate cement-prosthesis interface. This posterior plane facet has been demonstrated in a cadaver study to be the weak point of the femoral component due to an incomplete cement mantle, which is ultimately where the fatigue failure of the component occurred [26]. In our case, a radiolucency was noted at the level of the posterior femoral condyle at 6-year follow-up; however, the patient was having more symptoms from his lateral and patellofemoral compartments at that time.

Monk et al. described using lateral radiographs obtained in flexion and extension to detect UKA femoral loosening [27]. They consider the implant loose if gaps are present at the component-cement interface on one view but not the other [27]. We did not obtain lateral radiographs in both flexion and extension at 6-year follow-up. This may have assisted in further identifying any femoral loosening, although this still may have been difficult to detect because the anterior flange was well fixed intraoperatively at conversion to TKA.

We suspect the associated catastrophic polyethylene wear pattern, which also occurred in this case, was secondary to the loose posterior femoral flange causing cantilever bending on the polyethylene. If the femoral component is positioned in an eccentric position from the center of the tibial component, the stress distribution would be altered [28]. This ultimately increases edge loading of the UKA throughout the range of motion, which can lead to more rapid polyethylene wear [29]. The femoral component was well centered in this case, but the poor fixation likely led to micromotion of the implant, causing increased contact stresses, which ultimately exceeded the limits of the polyethylene and metal.

Another factor that may have contributed to increased stress on this UKA implant is the patient's progressive increase in BMI from 30 at his primary UKA to 38 at its ultimate failure. When UKA was initially introduced, indications were established and deemed that patients should weigh less than 180 lbs [30]. This was thought to decrease stress on the implant and lead to longer implant survivorship. Recent studies have since refuted these weight restrictions and demonstrated no difference in functional scores or implant survival in patients weighing over 180 lbs or with BMI over 30 [31,32]. UKA may have broader BMI and weight indications with modern implants. At our institution, surgeons have variable BMI limits for UKA but will counsel all patients with BMI greater than 35 on weight loss and medical optimization prior to considering UKA. We believe that this patient was appropriately selected to undergo UKA as his BMI was 30 on presentation, and he met our indications for UKA with isolated medial compartment osteoarthritis, stable ligamentous exam, correctable varus deformity of <10 degrees, <15 degrees of flexion contracture, and preserved range of motion. In this case, the large BMI increase over the postoperative period likely was a secondary factor that overwhelmed the already loose implant, leading to its failure.

Our patient also received a viscosupplementation injection at 6 years postoperatively to treat the progression of his osteoarthritis conservatively. It is unclear what effect this may have had on the UKA implant as there is currently a lack of evidence regarding viscosupplementation after UKA. This is not routinely a part of our treatment protocol for patients with osteoarthritis progression after UKA, but after engaging with the patient in shared decision-making, we determined this to be a reasonable option. We suspect the posterior flange of the femoral component was loose prior

to this injection, but we cannot determine whether this caused further loosening or had any effect on the implant. This may be an area of future research to determine its efficacy and impact on implant survival.

Summary

This unique case of catastrophic failure of a UKA femoral component with fatigue fracture highlights the importance of proper surgical technique, patient selection, and postoperative monitoring. Special attention should be paid to the posterior femoral condylar cut when preparing the femur for UKA implantation with a focus on creating an adequate cement-prosthesis interface. In addition, encouraging a healthy weight is important to preventing increased implant stress. Further study is needed to determine the safety and efficacy of viscosupplementation injection for treatment of osteoarthritis progression following UKA. Our case demonstrates that with poor posterior femoral fixation, it is possible for the anterior femoral component to remain well fixed and lead to femoral component fracture secondary to a cantilever mechanism on the polyethylene.

Conflicts of interest

The authors declare there are no conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2024.101321.

Informed patient consent

The author(s) confirm that written informed consent has been obtained from the involved patient(s) or if appropriate from the parent, guardian, power of attorney of the involved patient(s); and, they have given approval for this information to be published in this case report (series).

CRediT authorship contribution statement

Kenneth Ierardi: Writing – review & editing, Writing – original draft, Resources, Formal analysis, Data curation, Conceptualization. **Matthew Hammond:** Writing – review & editing, Writing – original draft. **William C. Searls:** Writing – review & editing, Writing – original draft. **Kenneth Scott:** Writing – review & editing, Writing – original draft, Supervision.

References

[1] Crawford DA, Rutledge-Jukes H, Alexander JS, Lombardi Jr AV, Berend KR. 15-Year follow-up of mobile bearing medial unicompartmental knee arthroplasty. J Arthroplasty 2023;38:1257–61.
[2] Emerson Jr RH, Higgins LL. Unicompartmental knee arthroplasty with the oxford prosthesis in patients with medial compartment arthritis. J Bone Joint Surg Am 2008;90:118–22.
[3] Pandit H, Hamilton TW, Jenkins C, Mellon SJ, Dodd CAF, Murray DW. The clinical outcome of minimally invasive phase 3 Oxford unicompartmental knee arthroplasty: a 15 year follow-up of 1000 UKAs. Bone Joint J 2015;97-B:1493–500.
[4] Faour-Martín O, Valverde-García JA, Martín-Ferrero MA, Vega-Castrillo A, de la Red Gallego MA, et al. Oxford phase 3 unicondylar knee arthroplasty through a minimally invasive approach: Long- term results. Int Orthop 2013;37:833–8.
[5] Shichman I, Roof M, Askew N, Nherera L, Rozell JC, Seyler TM, et al. Projections and epidemiology of primary hip and knee arthroplasty in medicare patients to 2040-2060. JB JS Open Access 2023;8:e22.00112.
[6] American Joint Replacement Registry (AJRR). 2023 Annual report. Rosemont, IL: American Academy of Orthopaedic Surgeons (AAOS); 2023.
[7] Swedish Arthroplasty Register. The Swedish arthroplasty register 2022 annual report. Gothenburg, Sweden: The Swedish Arthroplasty Register; 2022.
[8] Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR). 2022 Hip, knee & shoulder annual report. Adelaide, South Australia: AOA National Joint Registry; 2022.
[9] Lim JW, Cousins GR, Clift BA, Ridley D, Johnston LR. Oxford unicompartmentalknee arthroplasty versus age and gender matched total knee arthroplasty: functional outcome and survivorship analysis. J Arthroplasty 2014;29:1779–83.
[10] Lombardi AV, Berend KR, Walter CA, Aziz-Jacobo J, Cheney NA. Is recovery faster for mobile-bearing unicompartmental than total knee arthroplasty? Clin Orthop Relat Res 2009;467:1450–7.
[11] Lyons MC, Macdonald SJ, Somerville LE, Naudie DD, Mccalden RW. Unicompartmental versus total knee arthroplasty database analysis is there a winner? Clin Orthop Relat Res 2012;470:84–90.
[12] Jennings J, Kleeman-Forsthuber L, Bolognesi M. Medial unicompartmental arthroplasty of the knee. J Am Acad Orthop Surg 2019;27:166–76.
[13] Carlson SW, Lu Y, Sierra RJ. Minimum 10-year survivorship of mobile-bearing unicompartmental arthroplasty: single surgeon, North American non-designer consecutive series. J Arthroplasty 2022;37:S88–93.
[14] van der List JP, Zuiderbaan HA, Pearle AD. Why do medial unicompartmental knee arthroplasties fail today? J Arthroplasty 2016;31:1016–21.
[15] Murray DW, Goodfellow JW, O'Connor JJ. The Oxford medial unicompartmental arthroplasty: a ten-year survival study. J Bone Joint Surg Br 1998;80:983–9.
[16] Liddle AD, Pandit H, Judge A, Murray DW. Effect of surgical caseload on revision rate following total and unicompartmental knee replacement. J Bone Joint Surg Am 2016;98:1–8.
[17] Luscombe KL, Lim J, Jones PW, White SH. Minimally invasive Oxford medial unicompartmental knee arthroplasty. A note of caution! Int Orthop 2007;31:321–4.
[18] Rea P, Short A, Pandit H, Price AJ, Kyberd P, Beard DJ, et al. Radiolucency and migration after Oxford unicompartmental knee arthroplasty. Orthopedics 2007;30(5 Suppl):24–7.
[19] Vasso M, Corona K, D'Apolito R, Mazzitelli G, Panni AS. Unicompartmental knee arthroplasty: modes of failure and conversion to total knee arthroplasty. Joints 2017;5:44–50.
[20] Riebel GD, Werner FW, Ayers DC, Bromka J, Murray DG. Early failure of the femoral component in unicompartmental knee arthroplasty. J Arthroplasty 1995;10:615–21.
[21] Mariani EM, Bourne MH, Jackson RT, Jackson ST, Jones P. Early failure of unicompartmental knee arthroplasty. J Arthroplasty 2007;22(6 Suppl 2):81–4.
[22] Price AJ, Waite JC, Svard U. Long-term clinical results of the medial Oxford unicompartmental knee arthroplasty. Clin Orthop 2005;435:171–80.
[23] Lewold S, Goodman S, Knutson K, Robertsson O, Lidgren L. Oxford meniscal bearing knee versus the Marmor knee in unicompartmental arthroplasty for arthrosis: a Swedish multicenter survival study. J Arthroplasty 1995;10:722–31.
[24] Argelo KD, Burger MA, Hoozemans MJ, Temmerman OP. Femoral component failure in the Oxford unicompartmental knee arthroplasty: a case report. J Med Case Rep 2014;8:419.
[25] Bouché PA, Ehkirch FP. A 180° spin of the femoral component in unicompartmental knee arthroplasty: a report of 2 cases. JBJS Case Connect 2022;12:1–6.
[26] Clarius M, Mohr G, Jaeger S, Seeger JB, Bitsch RG. Femoral fixation pattern in cemented Oxford unicompartmental knee arthroplasty – an experimental cadaver study. Knee 2010;17:398–402.
[27] Monk AP, Keys GW, Murray DW. Loosening of the femoral component after unicompartmental knee replacement. J Bone Joint Surg Br 2009;91:405–7.
[28] Crawford D, Berend K, Lombardi A. Management of the failed unicompartmental knee arthroplasty. J Am Acad Orthop Surg 2018;26:e426–33.
[29] Dobelle E, Aza A, Avellan S, Taillebot V, Ollivier M, Argenson JN. Implantation of the femoral component relative to the tibial component in medial unicompartmental knee arthroplasty: a clinical, radiological, and biomechanical study. J Arthroplasty 2022;37:S82–7.
[30] Kozinn SC, Scott R. Unicondylar knee arthroplasty. J Bone Joint Surg Am 1989;71:145–50.
[31] Hamilton TW, Pandit HG, Jenkins C, Mellon SJ, Dodd CAF, Murray DW. Evidence-based indications for mobilebearing unicompartmental knee arthroplasty in a consecutive cohort of thousand knees. J Arthroplasty 2017;32:1779–85.
[32] van der List JP, Chawla H, Zuiderbaan HA, Pearle AD. The role of preoperative patient characteristics on outcomes of unicompartmental knee arthroplasty: a meta-analysis critique. J Arthroplasty 2016;31:2617–27.