2 Indications for Unicompartmental Knee Arthroplasty: Which Knees Are Best?

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The incidence of joint replacement procedures has increased in recent years due in part to an increase in life span, an increasingly active population, and rising obesity rates [1]. Total-knee arthroplasty (TKA) has been reported as the gold standard for treatment of patients with severe knee osteoarthritis (OA). However, there continues to be patient dissatisfaction with modern implant designs. Part of this dissatisfaction is related to postoperative pain, stiffness, and a lengthy and difficult rehabilitation [1]. Initially, unicompartmental knee arthroplasty (UKA) was controversial [2]. As techniques and implant designs have improved, studies have demonstrated that UKAs are durable and reliable procedures and are a viable surgical option for treating a subset of OA of the knee [2, 3].

Unicompartmental knee arthroplasty currently constitutes 8–10% of arthroplasties performed in the United States and the United Kingdom [4]. The potential advantages of UKA over TKA include improved functional outcomes, gait, proprioception, faster recovery, and less blood loss in addition to preservation of native bone stock and the cruciate ligaments [4]. Numerous studies have reported faster recovery and clinical benefit of UKA compared to TKA [5–7]. However, concerns regarding long-term survivorship have been voiced for UKA. Changes in implant designs and techniques have sought to improve long-term survivorship and function. Lyons et al. (2012) reported Kaplan–Meier survivorship at 5 and 10 years of 95% and 90% for UKA versus 98% and 95% for TKA in a large retrospective database analysis [8]. Price et al. (2011) reported on long-term follow-up of 682 Oxford mobile bearing medial compartment UKAs with 91% survivorship at 20 years [2]. A recent multicenter study reported 98.8% survivorship at 2.5 years and 97.5% survivorship of 432 robotic-arm-assisted fixed bearing medial UKAs at mean 5.7 years follow-up [3, 9]. Recently, a meta-analysis of survivorship of UKA versus TKA reported annual revision rates of 0.49% in TKA patients compared to 1.07% in medial UKA patients [10].

Prior studies have sought to compare results of unicompartmental versus total-knee arthroplasty [1, 7, 8, 11, 12]. Despite controlling for a number of different factors such as comorbidities, BMI, and age, these study groups did not control for the severity of osteoarthritis in each compartment of the knee. It is not a fair assumption that patients with tricompartmental OA are the same as patients with primarily medial compartment osteoarthritis. There are a small number of studies who have attempted to compare outcomes in patients with comparable preoperative radiographs with limited medial compartment OA and symptoms [5, 13, 14].

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Siman et al. (2017) performed a retrospective review of registry data from the Mayo Clinic of patients over the age of 75 years who underwent TKA or UKA. They analyzed preoperative radiographs and included those who met criteria for a medial UKA with a final comparison of 120 UKA and 188 TKA at mean 3.5 years follow-up. The authors found no significant difference in Knee Society Scores (KSS) between the included UKA and TKA patients (85.4 vs. 84.0) at minimum 2-year follow-up. They found no difference in 5-year survivorship estimates of UKA and TKA at 98.3% versus 98.8% respectively in their analysis [5]. Newman et al. (2009) reported their 15-year results of a randomized trial of UKA versus TKA for treatment of medial compartment OA and reported no difference in survivorship or complications with improved clinical outcomes in the UKA group [13]. Yang et al. (2003) compared the 6-month outcomes of patients who underwent UKA or TKA with primarily medial compartment OA, and found quicker recovery of function, improved range of motion, and shorter hospitalization with UKA [14].

Cost-effectiveness analyses have evaluated UKA versus TKA and have demonstrated that results are sensitive to survivorship and risk of revision for UKA [11, 12]. In addition, cost-effectiveness analyses have generally assumed that functional outcomes are similar with UKA and TKA [15, 16]. Baker et al. (2013) demonstrated that survivorship has been associated with surgeon volume with reported 96% 5-year survivorship in centers with >50 procedures performed per year [17].

There continues to be a debate over what is the most effective treatment for symptomatic primary medial compartment OA. The importance of accurate restoration of ideal alignment in the prevention of opposite compartment degeneration and component failure is critical in UKA [1]. Recently, robotic-assisted UKA has been employed to improve postoperative alignment with demonstrated accuracy in a randomized controlled trial comparing MAKO® robot-assisted versus traditional Oxford instrumentation UKA [4].

Return to activity continues to be an important factor after knee arthroplasty. Patients often present with the expectation of return to the activities they enjoyed prior to their limitations from knee OA. A recent systematic review by Waldstein et al. (2017) reported that patients following a UKA were physically active, and had a significant increase in low-impact activities and a decrease in high-impact activities [18]. Furthermore, the return to activity rate ranged from 87% to 98% [18]. Walton et al. (2006) demonstrated a higher rate of return to sport after UKA versus TKA [7]. Naal et al. (2007) demonstrated a return to activity rate of 95% in a cohort of UKA patients [19].

Indications for an UKA vary widely with no consistently agreed-upon treatment path among surgeons. In addition to clinical exam, radiographic imaging is performed during the preoperative workup and evaluation (Fig. 2.1) to identify whether a patient meets the radiographic criteria for a UKA. Deshmukh et al. (2001) defined unicompartmental candidates as having (1) noninflammatory arthritis, (2) a mechanical axis that deviates no more than 10 degrees from neutral for a varus knee or 15 degrees for a valgus knee, (3) an intact anterior cruciate ligament without signs of mediolateral subluxation of the femur on the tibia, and (4) the patellofemoral compartment can have Grade II or III Kellgren–Lawrence changes without patellofemoral joint (PFJ) symptoms [20, 21]. These criteria are more inclusive than the traditional Kozinn and Scott criteria, which included additional parameters of age > 60 years, weight < 82 kg, not heavy laborers or extremely active, reproducible pain with weight-bearing and activity with minimum pain at rest, range of motion to 90° of flexion with no more than a 5° flexion contracture, no more than 10° of varus or 15° of valgus that is passively correctable, intact ACL, noninflammatory arthritis, no chondrocalcinosis, and no PFJ symptoms [22].

Recently, the indications for UKA have expanded. With traditional selection criteria, 6% of osteoarthritic knees may meet criteria for an UKA [23]. However, using expanded criteria for the Oxford UKA, it has been reported that up to half of patients may benefit from a UKA [24]. Hamilton et al. (2017) published a consecutive series of 1000 mobile bearing UKA in which the traditional Kozinn and Scott criteria were not fol-

Fig. 2.1 Preoperative radiographic workup of 63-year-old male patient with primary complaints of medial joint line tenderness with ambulation who had failed conservative measures. Standing full length lower extremity films (**a**) in addition to anteroposterior view (**b**), lateral view (**c**), posteroanterior flexed view (**d**), and merchant view (**e**) are shown

lowed [25]. Of these, 68% of the UKAs would have been excluded by traditional criteria for an UKA in their series. The authors used their previously reported indications for Oxford medial UKA for the treatment of anteromedial osteoarthritis and spontaneous osteonecrosis of the knee including (1) bone-on-bone arthritis in the medial compartment; (2) retained full-thickness cartilage in the lateral compartment, best visualized on a valgus stress X-ray; (3) a functionally normal medial collateral ligament; and (4) a functionally normal anterior cruciate ligament. The status of the PFJ, with the exception of bone loss with grooving laterally, was not considered a contraindication to Oxford UKA. They reported no difference in American Knee Society Objective Scores or Oxford Knee Scores at a mean follow-up of 10 years, with a significantly lower number of poor outcomes in those who did not meet all criteria and no difference in 15-year implant

survival (90.7% in contraindication group vs. 88.5% in no contraindication group) [25].

Patient demographics are often controversial as well. Some studies do not recommend UKA for young active individuals or obese individuals due to the increased forces, which could overload the joint [1, 3]. Hamilton et al. (2017) performed a subgroup analysis of their cohort of patients who did not meet traditional restrictions of age > 60 years, weight < 180 pounds, increased activity, chondrocalcinosis, and patellofemoral joint disease, finding no difference in survivorship at 15 years [25].

The effects of weight and BMI on UKA outcomes and survivorship have been studied by multiple groups [26]. Pearle et al. (2017) reported a higher annual revision rate in those patients with a BMI ≥ 35 kg/m^2 (1.36% vs. 0.28% in BMI 18.5–24.9 kg/m^2) [3]. Haughom et al. (2015) demonstrated in a NSQIP database analysis of 2316 UKAs that increased BMI was a significant risk factor for revision [27]. Similarly, Kandil et al. (2015) performed an analysis of 15,770 UKAs in the PearlDiver database and demonstrated that obesity (BMI 30–39 kg/m^2) and morbid obesity (BMI ≥ 40 kg/m^2) were risk factors for complications and revisions [28]. Interestingly, Bonutti et al. (2011) showed decreased survivorship of 88% versus 100% at 3 years in patients with BMI ≥ 35 kg/m^2 [29]. Berend et al. (2005) also found that a BMI > 32 kg/m^2 was predictive of failure in their consecutive series of 79 UKA at minimum 2-year follow-up [30].

Other studies did not find a correlation between high BMI and revision rates at mid- and long-term follow-up. Murray et al. (2013) found no association with increasing BMI and implant survivorship in their analysis of 2438 medial Oxford mobile bearing UKAs at 5-year follow-up. Cavaignac et al. (2013) also found no difference in 10-year survivorship results when divided by weight (93.5% in weight ≥ 82 kg vs. 92.5% in weight < 82 kg) and BMI thresholds (92% in BMI ≥ 30 kg/m^2 vs. 94% in BMI <30 kg/m^2) [31].

Hamilton et al. (2017) compared those patients who underwent Oxford mobile bearing UKA, who met weight restriction of 180 pounds and those who were above this threshold (45%) [25]. The overweight group weighed on average 209 pounds (range 180–408 pounds) and they found no difference in 15-year implant survival or means of failure between the groups and reported no significant difference in 10-year functional outcome measures [25]. Similarly, van der List et al. (2016) performed a large meta-analysis of 31 comparative cohort studies and 6 registries demonstrating no significantly increased likelihood for inferior outcomes or revisions in patients with obesity defined as BMI ≥ 30 kg/m^2 (revision rate of BMI < 30 kg/m^2 group OR 0.71, 95% CI[0.48–1.06]) [32]. Patients with an increased weight or BMI should be counseled on the preoperative risks and the conflicting evidence regarding implant survivorship and be encouraged to lose weight to help improve this modifiable risk factor.

Age over 60 was initially reported as a threshold for UKA in the Kozinn and Scott criteria [22]. Multiple studies have examined this threshold and its effect on outcomes and survivorship. Harrysson et al. (2004) demonstrated that younger patients had an increased risk of revision after UKA in the Swedish Knee Arthroplasty Registry [33]. In a meta-analysis of reported outcome measures and revision rates from 31 cohort studies and 6 registries, age < 60 years was not found to be associated with a significant difference in functional outcomes or an increased risk of revision surgery (in studies: OR, 1.52; 95% CI, 1.06–2.19; in registries: OR, 2.09; 95% CI, 1.70–2.57) [32]. In contrast, Hamilton et al. (2018) reported that in their cohort, with 25% of their cohort (245 UKA) under the age of 60, there was no difference in 15-year implant survival (94.8% in <60 year group vs. 91.3% in ≥60 years group, p = 0.7), time to failure, or mechanism of failure for age < 60 [25]. Additionally, the authors found a significant benefit for the under 60 group with improved American Knee Society Scores, Oxford Knee Scores, and Tegner Activity scores at 10-year follow-up [25]. Younger patients should be counseled preoperatively about their potential

risk for higher revision rates, as reported in the literature, for both UKA and TKA.

Patellofemoral joint osteoarthritis is not a contraindication to medial UKA if the patient is asymptomatic. Careful clinical exam and intraoperative assessment should be performed to determine if UKA is appropriate. A long-term study by Berger et al. (2004) identified progression of PFJ disease as a the primary mode of failure after fixed bearing medial UKA [34]. This differs from the findings of the meta-analysis performed by van der List et al. (2016) where preoperative patellofemoral osteoarthritis was not found to have an association with inferior clinical outcomes or survivorship [32]. These results are also supported by the findings of Hamilton et al. (2017): no significant differences in functional outcomes or implant survivorship were demonstrated in patients with exposed bone in the PFJ [25].

Most authors agree that ACL deficiency is a contraindication to medial UKA [20, 22]. However, a recent meta-analysis showed no difference in revision rates or clinical outcomes in those with ACL deficiency [32]. This finding is supported in a study by Boissonneault et al. (2013), where 46 medial Oxford mobile bearing UKA were implanted into ACL-deficient knees and compared to a matched cohort of ACL intact UKA [35]. At 5-year follow-up, no difference was reported in survivorship or functional outcomes [35]. The integrity of the ACL should be carefully assessed preoperatively and if a patient has complaints of pain and instability, consideration should be made for a TKA in these patients.

Overall, indications for UKA vary widely in the literature. Importantly, isolated compartment symptoms with activity, a correctable deformity, and noninflammatory arthritis are agreed upon. A detailed history and exam, in addition to radiographic workup, should be performed to identify ideal candidates for this operation. The exclusion of those patients with patellofemoral OA, under the age of 60 years, or over 180 pounds are not consistently supported and a discussion with the patient should be performed preoperatively regarding the risks of revision reported in those cohorts.

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