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Original research

Presence of a Lateral Trochlear Osteophyte Predicts Medial Unicompartmental Arthroplasty Failure at Midterm Follow-up

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ABSTRACT

Background: Specific clinical and radiographic risk factors for medial unicompartmental knee arthroplasty (UKA) failure are incompletely understood. The purpose of this study was to perform a midterm survivorship analysis of medial UKA from a single, nondesigner surgeon. Based on observations from clinical practice, we hypothesized that the presence of a lateral trochlear osteophyte on preoperative Merchant radiographs may be predictive of medial UKA failure secondary to progressive osteoarthritis (OA).

Methods: Patients who underwent a mobile-bearing medial UKA by a single surgeon with minimum 24 months of clinical follow-up from 2008 to 2019 were retrospectively identified. Radiographic parameters, including the presence of a lateral trochlear osteophyte, were measured. Kaplan-Meier survivorship analyses were performed. Cox proportional hazards models were used to evaluate variables as risk factors for UKA failure, defined as reoperation or component revision.

Results: A total of 233 UKAs were included. The mean age was 60 years, mean BMI 32 kg/m^2, and 53% of patients were male. The mean follow-up duration was 5.7 years (range, 2.0-13.1 years). Using any reoperation as an endpoint, the 10-year survival was 91%. Using any component revision as an endpoint, the 10-year survival was 93%. Using revision due to progressive OA as an endpoint, the 10-year survival was 95%. The presence of a lateral trochlear osteophyte was associated with an increased risk of any reoperation (hazard ratio 3.6; 95% confidence interval 1.3-9.5) and increased risk of revision due to progressive OA (hazard ratio 9.8; 95% confidence interval 2.9-32.7).

Conclusions: The presence of a lateral trochlear osteophyte on preoperative Merchant view radiographs was associated with an increased risk of medial UKA failure.

Introduction

The volume of medial unicompartmental knee arthroplasties (UKAs) has increased in the United States over the past 20 years [1,2]. This may be secondary to expanded indications as there is a growing body of literature supporting utilization of medial UKA in elderly patients, overweight or obese patients, patients with patellofemoral joint osteoarthritis (OA), and patients with anterior cruciate ligament-deficient knees [3–12].

The Oxford UKA is a commonly used medial UKA implant [4,13–16]. Described failure modes of medial UKA at midterm follow-up include progression of lateral or patellofemoral joint OA and aseptic loosening [13,15–18]. Midterm to long-term follow-up studies have demonstrated rates of survivorship from 86% to 99% [4,13,15,16,18]. However, these data are derived from designer cohorts. Similarly, many survivorship studies include little to no investigation into specific clinical or radiographic risk factors for medial UKA failure [4,13,16,18,19]. The purpose of this study was to perform a midterm survivorship analysis of the medial UKA from a single, nondesigner surgeon and to identify specific clinical or radiographic variables that may increase the risk of UKA failure. Based on observations from clinical practice, we hypothesized that the presence of a lateral trochlear osteophyte on preoperative

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Merchant radiographs may be predictive of medial UKA failure secondary to progressive OA.

Material and methods

The study methodology was reviewed and approved by an institutional review board. A retrospective review of patients who underwent a medial UKA performed by a single fellowship-trained arthroplasty surgeon (N.O.N.) from January 1, 2008, to December 31, 2018, was conducted. Inclusion criteria consisted of medial UKA with an Oxford mobile-bearing prosthesis (Zimmer Biomet, Warsaw, IN), patients with intraoperative verification of competence of the anterior cruciate ligament, intraoperative verification of a lack of significant degenerative changes in the lateral compartments, and at least 24 months of clinical follow-up. In total, 278 UKAs in 217 patients were identified. Fourty-two patients (45 UKAs) had less than 2 years of follow-up and were excluded. In all 42 patients, at the most recent follow-up visit, no additional or revision surgery had been performed. A total of 233 UKAs in 175 patients were included for analysis. The mean follow-up duration was 5.7 years (range, 2.0-11.3 years). The primary outcome was UKA failure, defined as any reoperation, any component revision (excluding polyethylene exchange) [13,19], and conversion to total knee arthroplasty (TKA) for progression of lateral or patellofemoral OA.

Demographic data, including age at surgery, body mass index (BMI, kg/m^2), and diagnosis/surgical indication, were collected. Preoperative weight-bearing anteroposterior and lateral radiographs of the operative knee were measured for Kellgren-Lawrence (KL) grade [20], Ahlback grade [21], and combined Altman score [22] in the lateral and patellofemoral compartments (Table 1). Merchant radiographs were used to evaluate for the presence of a lateral trochlear osteophyte (Fig. 1). No formal definition or size criteria were used for determining the presence or absence of a lateral trochlear osteophyte; discretion was left to individual observers. Tibial slope and tibiofemoral angle [23] were measured on preoperative weight-bearing long-leg radiographs. Coronal and sagittal plane alignment of the tibial and femoral UKA components was measured on weight-bearing anteroposterior and lateral knee radiographs obtained 6 weeks postoperatively according to the previously published methodology [24,25]. Femoral and tibial components were classified as being appropriately positioned or not appropriately positioned in the coronal and sagittal planes based on previously published guidelines and recommendations from the implant manufacturer (between 5 and 10 degrees of femoral component flexion and less than 10 degrees of femoral component varus or valgus relative to the femur, between 2 and 12 degrees of posterior slope and less than 5 degrees of varus or valgus of the tibial component relative to the tibia) [8,26]. Radiographic measurements were performed by 3 independent observers; intrarater and interrater reliability studies yielded $\kappa \geq 0.80$ for all measurements, indicating excellent agreement [27].

Demographic variables are reported as descriptive statistics. Cox proportional hazard models were used to evaluate clinical and radiographic variables for each of the 3 UKA failure endpoints. Kaplan-Meier survivorship curves were generated for 2, 5, and 10 years postoperatively. Statistical analyses were performed using the SAS software (SAS Institute Inc., Cary, NC. Copyright 2021). Statistical significance was set at $P < .05$.

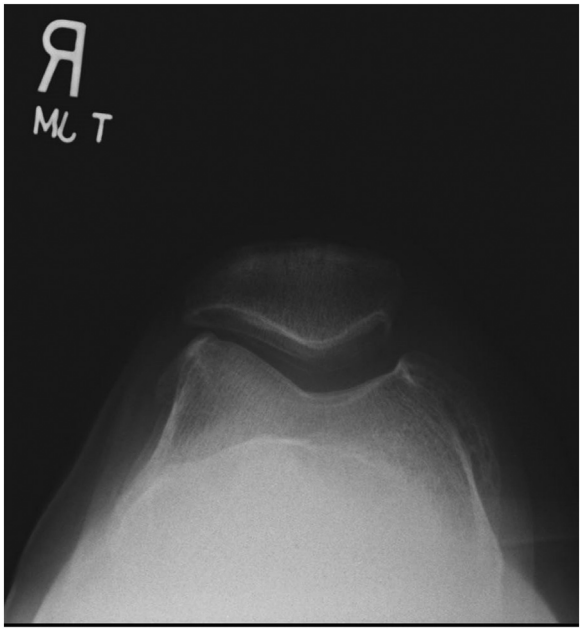

Figure 1. The Merchant radiograph of a right knee demonstrating an osteophyte on the lateral aspect of the trochlea.

Table 1
Classifications of disease.

Classification	Lateral compartment
KL grade [20]	
0	No OA
1	Doubtful OA
2	Minimal OA
3	Moderate OA
4	Severe OA
Ahlback grade [21]	
0	Normal joint space
1	Joint space narrowing
2	Joint space obliteration
3	Joint space obliteration with bone loss <5 mm
4	Joint space obliteration with bone loss >5 mm
5	Subluxation
Altman composite score [22]	Four criteria (joint space narrowing, subchondral sclerosis, presence of osteophytes, and bone loss) each graded 0-3; composite score is total of 4 criteria
0	None
1	Mild
2	Moderate
3	Severe

Results

The mean age of the cohort was 60 years (range, 29-87 years), mean BMI was 32 kg/m^2 (range, 20-54 kg/m^2), and 53% of patients were male. A total of 218 UKAs (94%) were performed for anteromedial OA, while 15 (6%) were performed for spontaneous osteonecrosis of the knee.

Preoperative radiographic grades of the lateral and patellofemoral compartments are contained in Table 2. One hundred and fifty-five knees (65%) were of KL grade 0 in the lateral compartment, and 103 knees (44%) were of KL grade 0 in the lateral compartment; 87 knees (37%) were of KL grade 0 in the lateral and patellofemoral compartments. Rates of appropriate positioning of the femoral component were 228/233 (98%) in the coronal plane and 210/233 (90%) in the sagittal plane. Rates of appropriate positioning of the tibial component were 198/233 (85%) in the coronal plane and 213/233 (91%) in the sagittal plane. Of the knees with malpositioning of the femoral component, 2 underwent conversion to TKA; 1 knee for aseptic loosening of the tibial component and 1 for progression of OA. Of the knees with malpositioning of the tibial

Table 2
Preoperative grading of lateral and patellofemoral compartments.

Classification	Lateral compartment	Patellofemoral compartment
KL grade (n, %)		
0	151 (65)	103 (44)
1	58 (25)	97 (42)
2	24 (10)	33 (14)
3 or 4	0 (0)	0 (0)
Ahlback grade (n, %)		
0	219 (93)	224 (96)
1	13 (6)	9 (4)
2	1 (1)	0 (0)
3	0 (0)	0 (0)
4 or 5	0 (0)	0 (0)
Altman composite score (n, %)		
0	151 (65)	103 (44)
1	57 (24)	105 (45)
2	19 (8)	24 (10)
3	6 (3)	1 (1)
4-12	0 (0)	0 (0)
Lateral trochlear osteophyte (n, %)		
Yes		20 (9)
No		213 (91)

component, 4 underwent conversion TKA; 1 for aseptic loosening of the tibial component and 3 for progression of OA.

In total, 23 of 233 (10%) UKAs underwent any reoperation. Indications for reoperation and mean time to any reoperation are contained in Table 3. Eighteen of 233 UKAs (8%) underwent any component revision at a mean duration of 4.6 years (range, 1.0-10.2 years); 13 were due to progressive OA, 3 were due to aseptic loosening of the tibial component, 1 was due to polyethylene damage secondary to a cement loose body, and 1 was due to bearing instability. All 18 procedures with any component revision consisted of conversions to TKA. Conversion TKA for progressive OA occurred at a mean duration of 5.2 years postoperatively (range, 1.0-10.2 years) (Table 3). All knees that were revised for progressive OA demonstrated radiographic progression of OA in both the lateral and patellofemoral compartments.

Using any reoperation as an endpoint, the 2-year survival was 96%, 5-year survival was 93%, and 10-year survival was 91% (Fig. 2). The presence of a lateral trochlear osteophyte (hazard ratio [HR] 3.6, 95% confidence interval 1.3-9.5) and an Altman composite score of $\geq$3 in the lateral compartment (HR 4.9, 95% CI 1.4-16.8) were associated with increased risk of any reoperation.

Using any component revision as an endpoint, the 2-year survival was 95%, 5-year survival was 95%, and 10-year survival was 93% (Fig. 3). The Altman composite score of $\geq$3 in the lateral compartment (HR 12.3, 95% CI 3.7-41.2) was associated with increased risk of any component revision.

Using conversion TKA for progressive OA as an endpoint, the 2-year survival was 99%, 5-year survival was 97%, and 10-year survival was 95% (Fig. 4). The presence of a lateral trochlear osteophyte (HR 9.8, 95% CI 2.9-32.7) and an Altman composite score of $\geq$3 in the lateral compartment (HR 9.6, 95% CI 1.9-47.5) were associated with increased risk of conversion TKA for progressive OA.

Increasing age at the time of surgery, increasing BMI, diagnosis of spontaneous osteonecrosis of the knee, increasing preoperative tibial slope, increasing preoperative varus or valgus tibiofemoral angle as measured on weight-bearing long-leg radiographs, femoral component malposition in the coronal plane, femoral component malposition in the sagittal plane, tibial component malposition in the coronal plane, and tibial component malposition in the sagittal plane were not associated with increased risk of any reoperation, any component revision, or conversion TKA for progressive OA ($P > .05$ for all).

Discussion

The purpose of this study was to perform a midterm survivorship analysis of medial UKA from a single, nondesigner surgeon and to identify specific clinical or radiographic variables that may increase the risk of UKA failure. We demonstrate 10-year survivorship rates of 91%, 93%, and 95% for endpoints of any reoperation, any component revision, and conversion TKA for progressive OA, respectively. An Altman composite score of $\geq$3 in the lateral compartment (indicative of an increased disease burden) was associated with increased risk of any reoperation, any component revision, and conversion for progressive OA. The presence of a lateral trochlear osteophyte on preoperative Merchant view radiographs was associated with an increased risk of any reoperation and conversion TKA due to progressive OA. To our knowledge, this study is the first to identify the presence of a lateral trochlear osteophyte as a preoperative marker of an increased risk of medial UKA failure at midterm follow-up. This can be quickly identified on routine radiographs and may be of value for identifying patients at risk of earlier failure when considering UKA.

Medial mobile-bearing UKA has been demonstrated to be a successful and durable procedure for patients with anteromedial OA and osteonecrosis of the medial compartment of the knee [4,13,15,16,18]. Recent studies' estimates of midterm to long-term follow-up demonstrates rates of survivorship from 86% to 99% [4,13,15,16,18]. Notably, much of these follow-up data are derived from series from designer surgeons. Alnachoukati et al. [13] examined a cohort of 825 medial mobile-bearing UKA and found an implant survivorship of 90% at a mean follow-up of 9.7 years. The most common mode of failure in this cohort was arthritis progression (22 cases, 24% of revisions), followed by aseptic loosening of the tibial component (19 cases, 20% of revisions) [13]. Pandit et al. [16] evaluated a cohort of 1000 medial mobile-bearing UKAs implanted using a minimally invasive approach at a mean follow-up of 5.6 years. The authors noted a 10-year survivorship of 96% when using an endpoint of all implant-related reoperations [16]. The most common cause of reoperation was development of OA in

Table 3
Indications for reoperation.

Indication	Reoperation procedure	Frequency (n, %)	Time to reoperation (mean, range)
Progressive OA	Conversion TKA	13 (57)	5.2 y (1.0-10.2 y)
Aseptic loosening, tibial component	Conversion TKA	3 (13.5)	3.7 y (1.9-7.0 y)
Periprosthetic joint infection	Irrigation and debridement, polyethylene exchange	3 (13.5)	4 mo (0.5-8 mo)
Bearing instability	Conversion TKA	1 (4)	1.9 y
Polyethylene damage due to cement loose body	Conversion TKA	1 (4)	1.2 y
Superficial surgical site infection	Irrigation and debridement	1 (4)	1 mo
Arthrofibrosis	Manipulation under anesthesia	1 (4)	2 mo

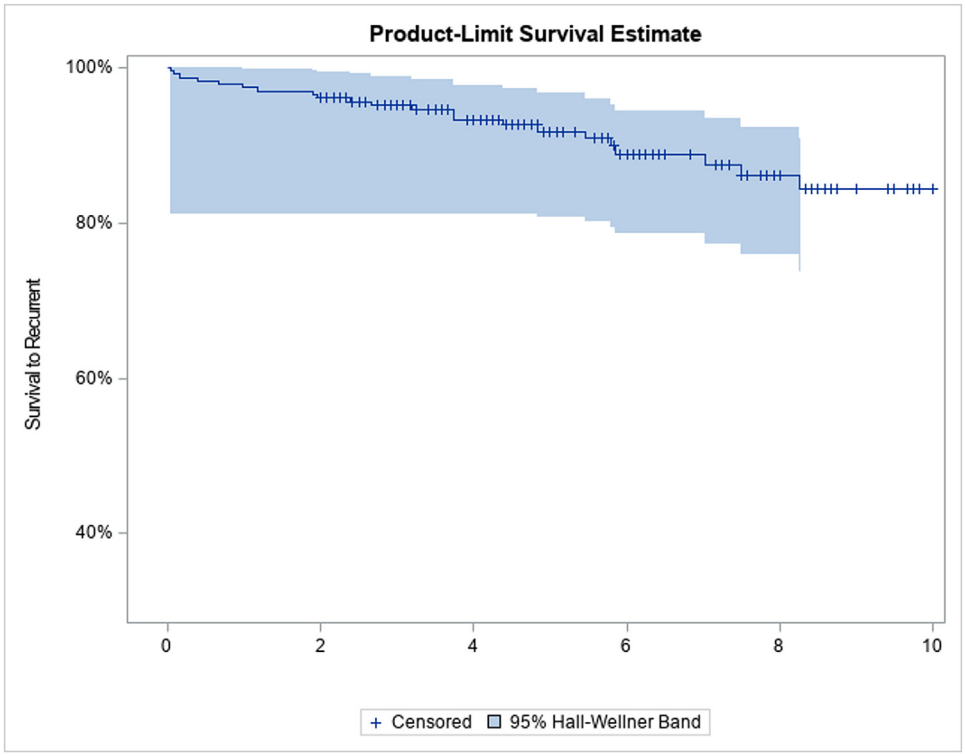

Figure 2. The Kaplan-Meier survivorship curve with endpoint of any reoperation at 10 years postoperatively. The blue shading represents 95% confidence interval.

the lateral compartments (9 cases, 31% of all reoperations), occurring at a mean of 5 years after the index surgery. Lisowski et al. [15] evaluated 138 medial mobile-bearing UKAs at a mean follow-up of 11.7 years. Using an endpoint of all-cause revision, the 15-year survivorship rate was 90%. In total, 11 UKAs underwent conversion to TKA at a mean duration of 5.7 years after the index surgery;

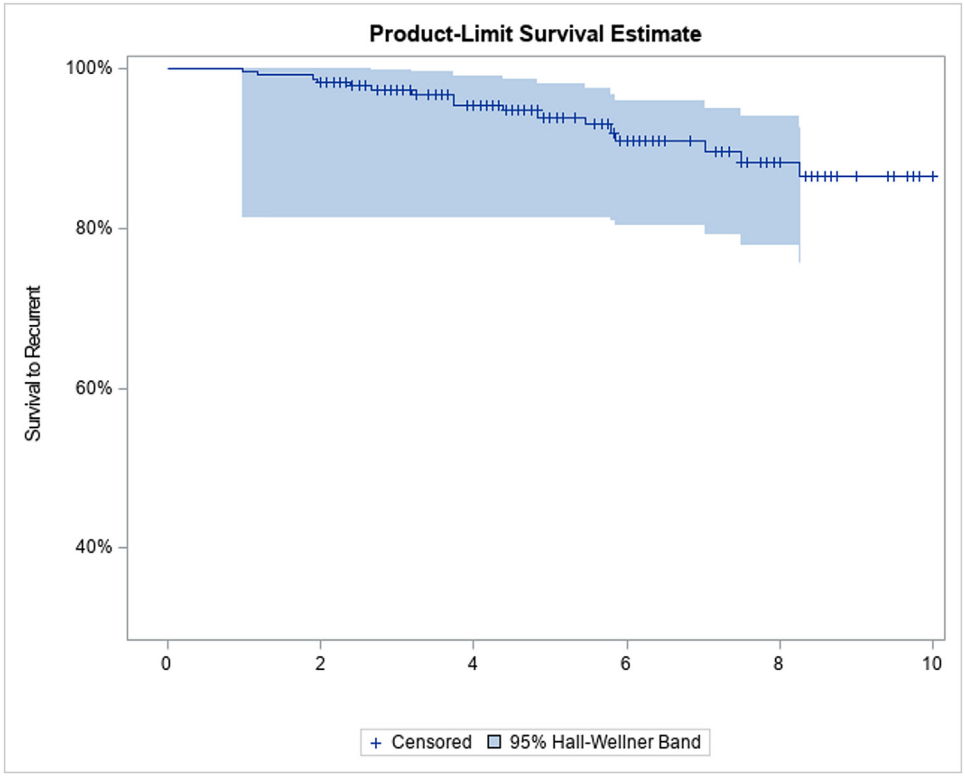

Figure 3. The Kaplan-Meier survivorship curve with endpoint of any component revision at 10 years postoperatively. The blue shading represents 95% confidence interval.

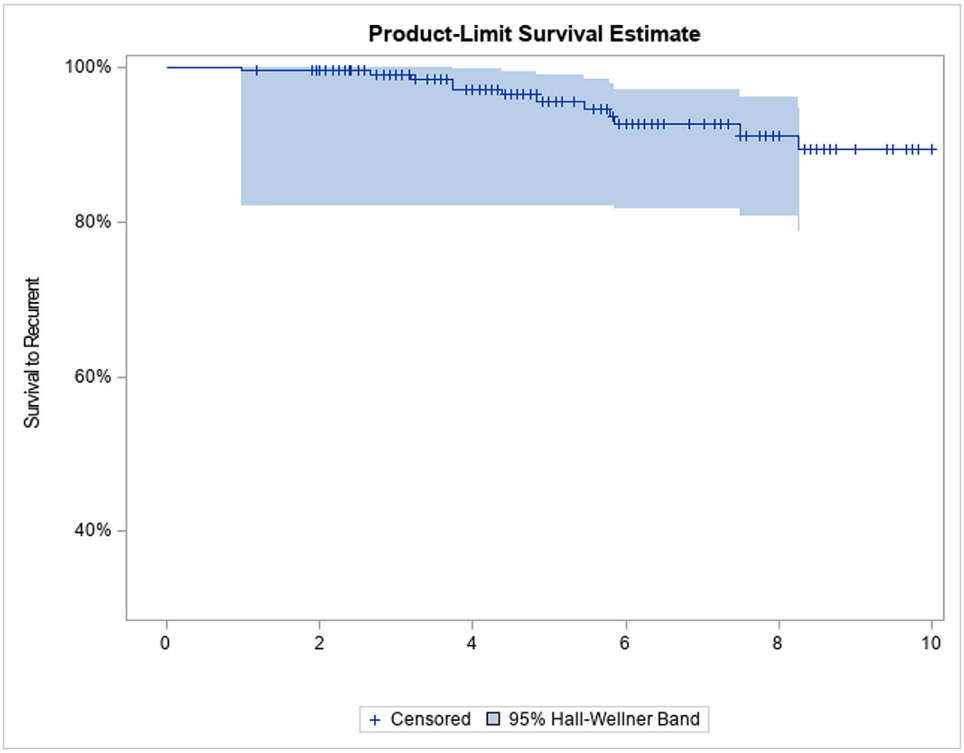

Figure 4. The Kaplan-Meier survivorship curve with endpoint of conversion TKA due to progressive OA at 10 years postoperatively. The blue shading represents 95% confidence interval.

6 (55%) were due to progressive OA in the lateral or patellofemoral compartment. We noted similar findings in the present study; the most common reason for reoperation was progressive OA (57%) at a mean duration of 5.2 years after the index surgery. Interestingly, the rate of conversion TKA due to progressive OA in the present study was most comparable to that of Lisowski et al. [15], another nondesigner series, relative to previously published designer series [13,16].

The presence of a lateral trochlear osteophyte on a preoperative Merchant view radiograph has not previously been described as a risk factor for midterm failure of medial mobile-bearing UKA. In the present study, we found this to be associated with a higher risk of any reoperation (HR 3.6, 95% CI 1.3-9.5) and a conversion TKA due to progressive OA (HR 9.8, 95% CI 2.9-32.7). These data suggest that the presence of a lateral trochlear osteophyte (Fig. 1) on a preoperative Merchant view radiograph may be an easily recognized marker of lateral tibiofemoral and/or lateral patellofemoral joint disease that may predispose medial mobile-bearing UKA to a higher risk of revision surgery relative to baseline. Prior investigations have emphasized the need for radiographic demonstration of the maintained joint space of the lateral tibiofemoral compartment for success of a medial mobile-bearing UKA [28,29]. Of the 20 knees in the present study that had a lateral trochlear osteophyte, all 20 had a lateral tibiofemoral joint KL grade of 2 or less, indicating that minimal/no lateral joint space narrowing was present [20,30]. Thus, in terms of utility as a radiographic marker to assist in guiding surgical indications, the presence of a lateral trochlear osteophyte may have 2 distinct advantages over simply checking for a maintained lateral tibiofemoral joint space: (1) a greater discriminatory power in detecting patients that may fail medial mobile-bearing UKA at midterm follow-up and (2) appearing on radiographs before significant tibiofemoral joint space narrowing is perceptible.

The presence of a lateral trochlear osteophyte may also be a marker of lateral patellofemoral joint disease. Previous studies have discussed OA within the patellofemoral joint as part of indications for a medial UKA [15,31–33]. Lisowski et al. [15] stated that patellofemoral OA was not a contraindication to medial mobile-bearing UKA in their recent series. The authors did note that 2 patients (4 knees) developed OA of the lateral facet of the patellofemoral joint during the study follow-up; 50% of these knees were symptomatic and were revised to primary TKA [15]. In contrast, 2 knees that developed OA of the medial facet of the patellofemoral joint remained asymptomatic. Kang et al. [33] evaluated a cohort of 195 medial mobile-bearing UKAs at a mean duration of 3.4 years postoperatively. They noted a preoperative rate of patellofemoral joint OA of 64% and found no difference in Oxford knee scores or Short Form-12 scores between knees with and without patellofemoral joint OA [33]. The authors concluded that isolated patellofemoral OA should not be considered a contraindication to medial mobile-bearing UKA [33]. Beard et al. [31] studied a cohort of 100 medial mobile-bearing UKAs and found that 54% of knees had preoperative anterior knee pain and degenerative changes in the patellofemoral joint. At 2 years of follow-up, knees with medial patellofemoral joint OA had higher Oxford knee scores than knees without the patellofemoral disease [31]. Additionally, knees with lateral patellofemoral joint OA had lower Oxford knee scores than knees without lateral patellofemoral OA; the authors advised utilizing caution before performing medial mobile-bearing UKA in knees with lateral patellofemoral OA [31]. We would encourage arthroplasty surgeons to remain cognizant of this finding on preoperative radiographs when considering patients for medial mobile-bearing UKA.

Numbers of secondary reoperation outside of conversion TKA for progressive OA in the present study were low. Three UKAs (1.3%) developed a periprosthetic joint infection and were successfully

treated with irrigation and debridement, polyethylene exchange, and intravenous antibiotics. Bergeson et al. [19] noted a rate of irrigation and debridement and polyethylene exchange of 0.5% at minimum 2 years of follow-up in a cohort of 1000 medial mobile-bearing UKAs. Similarly, Pandit et al. [16] noted a rate of suspected PJI of 0.6% in a series of 1000 medial mobile-bearing UKAs at minimum of 5 years of follow-up. In the present study, 3 UKAs (1.3%) were converted to TKA after aseptic loosening of the tibial component. This rate is similar to rates previously published. Alnachoukati et al. [13] had 19 cases of aseptic tibial loosening out of 825 UKAs for an overall rate of 2.3%. Bergeson et al. [19] noted 11 UKA failures due to aseptic loosening of the tibial component for an overall rate of 1%.

The present study has several limitations. As a retrospective cohort study, study data are subject to elements of selection and nonresponse bias; however, the 2-year follow-up rate in this study was 84%. Patients lost to follow-up may influence overall rates of survivorship. Additionally, all patients in this study underwent UKA, and the proportion of patients with a lateral trochlear osteophyte who were not offered UKA is unknown. This study does not include any evaluation of patient-reported outcome measures; as such, clinical performance of the UKA outside of understanding if a patient had a revision surgery is not known.

Conclusions

In this single-surgeon series of medial mobile-bearing UKA, 10-year survivorship rates ranged from 91% to 95%, depending on the study endpoint. The presence of a lateral trochlear osteophyte and a combined Altman score of $\geq$3 were associated with higher risk of any reoperation and conversion TKA due to progressive OA. Arthroplasty surgeons should be cognizant of these radiographic findings at the time of indication for medial mobile-bearing UKA, and it may function as a simple screening tool. Patients with a lateral trochlear osteophyte may be counselled they may be at a higher risk of failure, and surgeons may give greater consideration to offering TKA to these patients.

Conflicts of interest

Drs. C. N. Carender and D. E. DeMik are in the editorial or governing board of the *Journal of Arthroplasty*. Dr. N. O. Noiseux is a paid consultant for and received research support as a principal investigator from Microport, Link Orthpaedics, and Smith and Nephew and is a program chair and member in the board of directors of Mid-America Orthopedic Association (MAOA). The other 2 authors declare no potential conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2022.09.013.

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