■ KNEE

Oxford domed lateral unicompartmental knee arthroplasty

TEN-YEAR SURVIVAL AND SEVEN-YEAR CLINICAL OUTCOME

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Aims

To report mid- to long-term results of Oxford mobile bearing domed lateral unicompartmental knee arthroplasty (UKA), and determine the effect of potential contraindications on outcome.

Methods

A total of 325 consecutive domed lateral UKAs undertaken for the recommended indications were included, and their functional and survival outcomes were assessed. The effects of age, weight, activity, and the presence of full-thickness erosions of cartilage in the patellofemoral joint on outcome were evaluated.

Results

Median follow-up was seven years (3 to 14), and mean age at surgery was 65 years (39 to 90). Median Oxford Knee Score (OKS) was 43 (interquartile range (IQR) 37 to 47), with 260 (80%) achieving a good or excellent score (OKS > 34). Revisions occurred in 34 (10%); 14 (4%) were for dislocation, of which 12 had no recurrence following insertion of a new bearing, and 12 (4%) were revised for medial osteoarthritis (OA). Ten-year survival was 85% (95% confidence interval (CI) 79 to 90, at risk 72). Age, weight, activity, and patellofemoral erosions did not have a significant effect on the clinical outcome or survival.

Conclusion

Domed lateral UKA provides a good alternative to total knee arthroplasty (TKA) in the management of lateral compartment OA. Although dislocation is relatively easy to treat successfully, the dislocation rate of 4% is high. It is recommended that the stability of the bearing is assessed intraoperatively. If the bearing can easily be displaced, the fixed rather than the mobile bearing version of the Oxford lateral tibial component should be inserted instead. Younger age, heavier weight, high activity, and patellofemoral erosions did not detrimentally affect outcome, so should not be considered contraindications.

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Introduction

Lateral unicompartmental knee arthroplasty (UKA) is an alternative to total knee arthroplasty (TKA) in the management of isolated lateral compartment osteoarthritis of the knee. UKA, compared to TKA, has been shown to have many advantages including quicker recovery, more normal joint function, and better patient-reported outcomes, although with a higher revision rate.[1] Lateral compartment osteoarthritis appropriate for lateral UKA is much rarer than medial compartment osteoarthritis appropriate for medial UKA. Accordingly, published series for lateral UKA tend to contain smaller numbers of patients than those of medial UKA.

The anatomy and kinematics of the lateral compartment of the knee are different to the medial, requiring different designs and surgical techniques to be used for medial and lateral UKA. The lateral tibial plateau is convex, and during flexion there is a large amount of movement of the lateral femoral condyle on the tibia.[2,3] In high flexion the femoral condyle drops down and articulates with the back of the tibial plateau.[4] To restore more closely normal anatomy and kinematics, the Oxford domed lateral UKA (Zimmer Biomet, Warsaw, Indiana, USA), with a convex tibial plateau and biconcave bearing,[5,6] was introduced in 2004. The lateral ligaments are lax in flexion allowing the lateral side to be distracted by, on average,

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7 mm, compared with 2 mm on the medial side.[7] This laxity led to a high dislocation rate with early designs of mobile bearing lateral UKA.[8] Subsequent improvements in surgical technique and implant design have seen an incremental decrease in the dislocation rate for mobile bearing lateral UKA.[9-12] Weston-Simons et al[13] previously evaluated 265 domed lateral UKA with a mean follow-up of four years and found a mean Oxford Knee Score (OKS) of 40, a reoperation rate of 4.5%, of which 1.5% were due to dislocation, and a survival at eight years of 92%. However, more recently other centres have published higher dislocation rates up to 6% over five years.[14]

The indications for the medial UKA are clearly defined and evidence-based.[15,16] Indications for Oxford domed lateral UKA reflect those for the medial side requiring bone-on-bone disease in the lateral compartment, full-thickness cartilage in the medial compartment, and functionally intact ligaments. A rarer indication is spontaneous osteonecrosis of the knee. Patient factors such as age, weight, activity level, and patellofemoral joint (PFJ) damage proposed by Kozinn and Scott[17] in 1989 to be contraindications for UKA have not been considered to be contraindications for the fixed bearing Oxford UKA.[18] However, as the effect these factors have on the outcome of mobile bearing lateral UKA have not been studied in detail, we do not know whether they should be contraindications.

The aims of this paper were firstly to describe the function and implant survival following Oxford domed lateral UKA out to ten years, and secondly to examine the effect of the previously described contraindications to UKA on outcomes.

Methods

Between September 2004 and December 2015, 325 consecutive domed lateral UKAs were implanted in 300 patients for the recommended indications by two designer surgeons (DM, CD). Domed lateral UKA used to treat lateral compartment arthritis following medial UKA were excluded. Indications for lateral UKA were similar to those used for medial Oxford UKA: all cases had significant symptoms with bone-on-bone osteoarthritis or spontaneous osteonecrosis of the knee in the lateral compartment and a functionally intact anterior cruciate ligament (ACL) with full-thickness cartilage in the weight bearing portion of the medial compartment. Any intra-articular valgus deformity was correctable. The state of the PFJ, patient's age, activity level, and weight were not considered contraindications. UKA was implanted even if there was severe lateral PFJ damage.

The 325 consecutive domed lateral UKAs were implanted in 300 patients with a mean age at operation of 65 years (SD 11; 39 to 90), and mean body mass index (BMI) of 28 kg/m^2 (SD 5; 17 to 48; Table I). Three knees in three patients had spontaneous osteonecrosis of the knee, the remaining knees had osteoarthritis. The mean preoperative OKS was 24 (SD 7; 2 to 46). Median follow-up was seven years (interquartile range (IQR) 3 to 14). Patients with 26 (8%) knees died due to reasons unrelated to the knee arthroplasty without requiring any further intervention to the knee. Scores were provided prior to their death. A further 13 (4%) withdrew from follow-up (nine due to age-related high-level care requirements, three no longer wished to be part of study, and one moved abroad), and none reported problems with their knee at time of withdrawal. One patient (one knee) was lost to follow-up.

Table I. Cohort demographics.

Characteristic	Outcome
Knees, n	325
Patients, n	300
Mean age at surgery, yrs (SD; range)	64.9 (11; 39 to 90)
Sex female, n (%)	204 (63)
Mean BMI (SD; range)	27.7 (5; 17 to 48)
Mean preop OKS (SD; range)	24.5 (9; 2 to 46)
Median preop Tegner activity score (IQR; range)	2 (2 to 3; 0 to 7)
Full-thickness PFJ lesion, n (%)	46 (14)

BMI, body mass index; IQR, interquartile range; OKS, Oxford Knee Score; PFJ, patellofemoral joint; preop, preoperative.

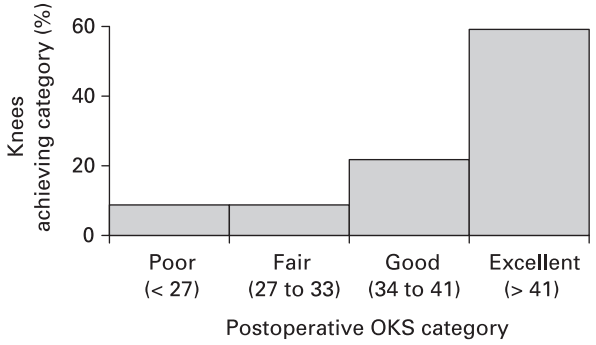


Fig. 1

Histogram of Oxford Knee Score (OKS) category following domed lateral unicompartmental knee arthroplasty (UKA), grouped as per Kalairajah et al.[23]

All procedures were carried out using the modified minimally invasive surgical technique for the Phase 3 Domed Oxford unicompartmental knee arthroplasty (OUKA).[19] This involved a lateral parapatellar skin incision with trans-patellar tendon incision for vertical tibial cut, internal rotation of the tibial component, anatomical positioning of the femoral component, and selection of the bearing thickness in full extension. This restores the normal situation in which the ligaments are tight in full extension and loose in flexion. All components were fixed with polymethylmethacrylate cement.

Patients were prospectively followed by research physiotherapists independent of the surgical and clinical teams. Patients were assessed routinely at one, five, seven, ten, and 12 years postoperatively, and with extra visits if a problem occurred. Patients were contacted by letter for a hospital clinic appointment. If they failed to respond, they were contacted by telephone. Scores recorded were the Oxford Knee Score (OKS),[20] the American Knee Society score functional (AKSS-F) and objective (AKSS-O),[21] and the Tegner activity score.[22] OKS was categorized as per Kalairajah et al[23] into excellent (> 41), good (34 to 41), fair (27 to 33), and poor (< 27). AKSS was categorized into excellent (85 to 100), good (70 to 84), fair (60 to 69), and poor (< 60). Revision was defined as the addition, removal, or exchange of any component, including bearing

Table II. List of revisions. Screw procedure involved addition of screws above the medial wall (Figure 4).

Patient number	Time to revision, yrs	Age:sex	Indication	Revision
1	0.05	39:F	Dislocation	Bearing exchange
2	0.06	68:M	Early infection	Debridement and bearing exchange
3	0.10	76:M	Dislocation	Bearing exchange + screws
4	0.15	78:M	Dislocation	Revision to fixed bearing
5	0.18	74:M	Dislocation	Bearing exchange
6	0.31	84:F	Dislocation	Bearing exchange + screws
7	0.35	69:F	Dislocation	Bearing exchange + screws
8	0.35	67:F	Dislocation	Bearing exchange
9	0.39	56:M	Dislocation	Bearing exchange + screws
10	0.53	51:F	Dislocation	Bearing exchange
11	0.54	59:F	Dislocation	Bearing exchange + screws
12	1.0	65:F	Infection	Revision to TKA (with stems)
13	1.4	59:M	Recurrent haemarthrosis	Revision to TKA
14	1.6	68:F	Traumatic bearing dislocation	Bearing exchange
15	1.8	42:F	Dislocation	Bearing exchange + screws
16	2.2	75:M	Recurrent haemarthrosis	Revision to TKA
17	2.6	60:M*	Progression of OA	Addition of medial UKA
18	2.9	54:M	Pain	Bearing exchange
19	4.0	40:M*	Dislocation	Bearing exchange + screws
20	4.0	44:M	'Locking knee' (revised elsewhere)	TKA at other centre
21	4.3	74:F	Infection post trauma (infected cerclage wire)	Revision to TKA
22	4.3	48:F	Pain (femoral component found to be loose)	Femoral component revision + bearing exchange
23	5.0	66:F	Progression of OA	Addition of medial UKA
24	5.5	53:F	Progression of OA	Revision to TKA
25	6.5	58:F	Progression of OA	Revision to TKA
26	7.0	53:M*	Progression of OA	Addition of medial UKA
27	7.2	60:F	Progression of OA	Revision to TKA
28	7.2	73:F*	Progression of OA	Revision to TKA
29	7.6	43:M	Progression of OA	Revision to TKA
30	8.7	43:F	Progression of OA	Revision to TKA
31	8.7	44:M*	Dislocation†	Bearing exchange
32	9.1	75:F	Progression of OA	Addition of medial UKA
33	9.3	63:F	Progression of OA	Addition of medial UKA
34	10.5	42:F	Progression of OA	Revision to TKA (elsewhere)

*Tegner score ≥ 5.
†Bearing dislocated whilst working under the sink.
F, female; M, male; OA, osteoarthritis; TKA, total knee arthroplasty; UKA, unicompartmental knee arthroplasty.

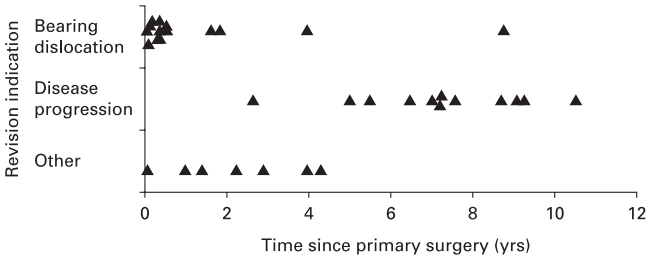


Fig. 2

Chart showing time point of failure for different revision indications. The majority of bearing dislocations occurred within the first year; contrasted with 83% (10/12) of disease progressions occurring after five years.

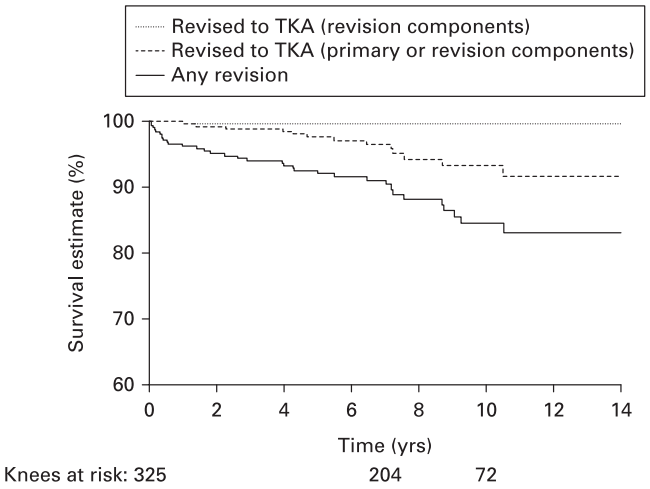


Fig. 3

Kaplan-Meier graph of domed lateral unicompartmental knee arthroplasty implant survival. TKA, total knee arthroplasty.

exchange for dislocation (or for any other indication), addition of medial UKA to the medial compartment, or conversion to TKA. We undertook a series of subanalyses based on all-cause revision, all-cause excluding dislocation, revision due to arthritis progression, conversion to TKA, and conversion to

revision TKA. In addition, we examined the effect on outcome of age, weight, activity level, and PFJ damage.

Statistical analysis. We used Stata v. 14.0 (STATA Corp, Texas, USA) and R statistical programming software (R Foundation, Vienna, Austria) for statistical analysis. For normally distributed variables, mean and SD were tested with an independent-samples *t*-test. For non-parametric data, median and IQR are reported, with a Wilcoxon's signed rank test performed for paired data, and Mann-Whitney U test for independent observations. Proportions were tested with a chi-squared test. Survival, with failure was assessed using Kaplan-Meier survival analysis, with significance tested with a log rank test. A p-value < 0.05 was considered significant.

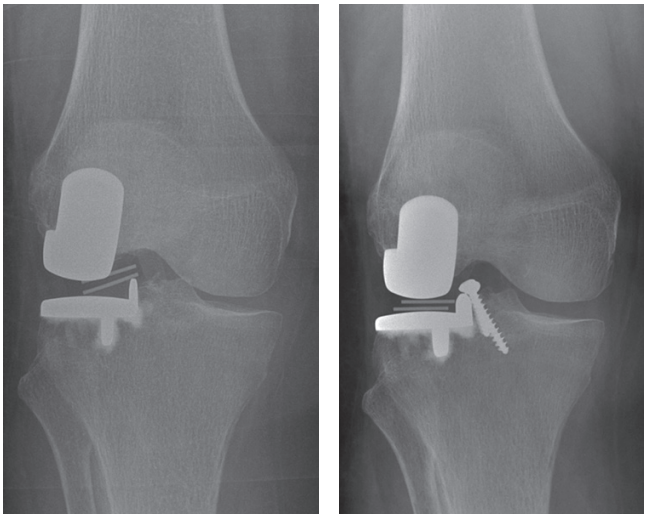
Results

Functional scores. There was a significant improvement in OKS, AKSS-O, AKSS-F, and the Tegner Activity Score (all $p < 0.001$, Wilcoxon's signed rank test). Median OKS was 43 (IQR 37 to 47), AKSS-O was 95 (IQR 85 to 99), AKSS-F 80 (IQR 60 to 100), and Tegner activity score 3 (IQR 2 to 3). OKS was available in 98% (317 knees) of the cohort, and by OKS criteria 60% (189 knees) achieved an excellent outcome (score > 41), 22% (71 knees) a good outcome (34 to 41), 9% (27 knees) a fair outcome (27 to 33), and 9% (30 knees) a poor outcome (< 27; Figure 1).

The AKSS-O was available in 79% (255 knees) of the cohort. According to AKSS-O criteria, 74% (189 knees) achieved an excellent outcome (85 to 100), 9% (24 knees) a good outcome (70 to 84), 9% (23 knees) a fair outcome (60 to 69), and 7% (19 knees) a poor outcome (< 60).

Survival. There were 34 (10%) revisions occurring at a mean 3.7 years (two weeks to ten years; Table II; Figures 2 and 3). Bearing dislocation occurred in 14 knees (4% of cohort); in ten of these the dislocation occurred medially, with two anterior and two unknown. Two of these dislocations were secondary to trauma. A total of 12 knees had progression of osteoarthritis within the knee (4%). Only one revision occurred for aseptic femoral loosening, one for deep infection, and two for recurrent haemarthrosis. Three of the knees had a bearing exchanged as part of explorations for a locking knee (n = 1), unexplained pain (n = 1), and an early superficial infection (n = 1). Finally, one knee sustained an unrelated patellar fracture which was internally fixed with a tension band wire. This wire subsequently became infected necessitating revision.

Five- and ten-year Kaplan-Meier survival estimates for all cause revision are 92.1% (95% CI 89 to 95, at risk 204), and 84.6% (95% CI 79 to 90, at risk 72). With failure for any indication excluding dislocation, survival estimates were 96.7% (95% CI 95 to 99, at risk 209) and 89.5% (95% CI 85 to 95, at risk 74). With failure due to progression of arthritis, survival estimates were 99.6% (95% CI 99 to 100, at risk 212), and 92.3% (95% CI 88 to 97, at risk 76). Considering failure as conversion to TKA, five- and ten-year survival estimates are 98.0% (95% CI 96 to 100, at risk 204) and 93.7% (95% CI 90 to 98, at risk 72). Considering failure as conversion to TKA requiring revision TKA components, five- and ten-year survival were 99.7% (95% CI 99 to 100, at risk 204), and 99.7% (95% CI 99 to 100, at risk 72).



a b

Fig. 4

a) Aligned anteroposterior (AP) radiograph of the knee of an 85-year-old female three months after primary surgery. The bearing has dislocated medially rising onto the wall. b) Aligned AP radiograph of the knee of same patient taken nine months later. Two screws had been inserted at time of dislocation to prevent further dislocation.

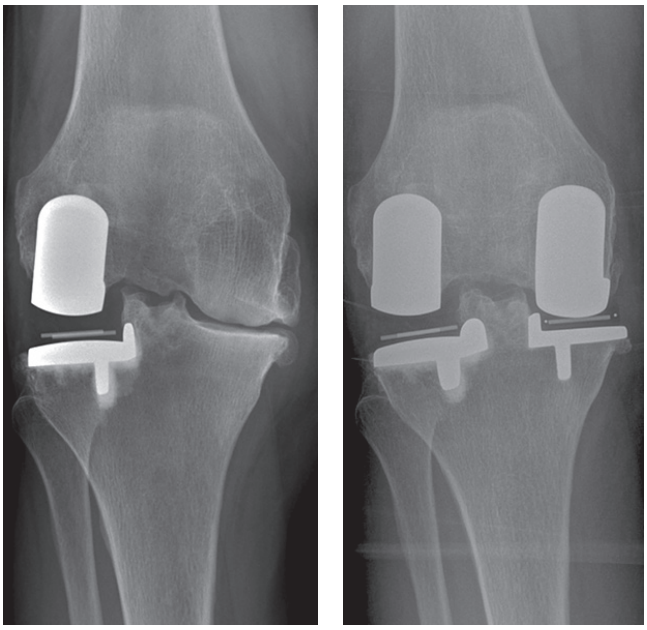


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Fig. 5

a) Aligned anteroposterior (AP) radiograph of the knee of a 72-year-old female nine years after her primary lateral Oxford unicompartmental knee arthroplasty (OUKA) showing progression of disease medially. b) Aligned AP radiograph of the same patient taken 13 months later with the addition of a medial unicompartmental arthroplasty.

The most common primary revision procedure was a bearing exchange. This occurred alone (n = 7), or was combined with

Table III. Demographics of subgroups.

Historical contraindication	n	Mean age, yrs (SD)	Mean BMI, kg/m² (SD)	Female, n (%)	Median preop Tegner (IQR)	Full-thickness PFJ at operation, n (%)	Median preop OKS (IQR)	Median follow-up, yrs (range)
Age < 60 years	107	52.0 (6)	28.2 (5)	52 (48)	3 (3 to 4)	15 (14)	22 (17 to 29)	7 (1 to 13)
Age ≥ 60 years	218	71.2 (7)	27.4 (5)	152 (69)	3 (2 to 3)	31 (14)	25 (19 to 31)	6 (1 to 14)
p-value		N/A	0.224*	< 0.001†	0.336	0.741†	0.048‡	0.027‡
Weight < 82 kg	173	67.4 (11)	24.9 (3)	144 (83)	3 (2 to 3)	24 (14)	26 (19 to 32)	7 (1 to 13)
Weight ≥ 82 kg	131	61.2 (10)	31.3 (4)	47 (36)	3 (3 to 3)	20 (15)	24 (18 to 29)	7 (1 to 14)
p-value		< 0.001*	N/A	< 0.001†	0.228	0.769†	0.058‡	0.656‡
Tegner score < 5	276	65.1 (11)	27.7 (5)	178 (64)	3 (2 to 3)	32 (12)	24 (18 to 31)	7 (1 to 14)
Tegner score ≥ 5	35	59.8 (11)	26.6 (3)	15 (42)	6 (5 to 6)	8 (23)	25 (23 to 32)	7 (1 to 12)
p-value		0.009*	0.075*	0.013†	N/A	0.027†	0.103‡	0.395‡
PFJ no bone exposed	239	64.4 (12)	27.6 (5)	152 (64)	3 (2 to 3)	0 (0)	24 (18 to 31)	7 (1 to 13)
PFJ bone exposed	46	66.4 (11)	28.1 (5)	26 (57)	3 (2 to 4)	46 (100)	25 (17 to 29)	7 (1 to 12)
p-value		0.303*	0.535*	0.364†	0.281	N/A	0.602‡	0.434‡

*Independent-samples *t*-test.
†Chi-squared test.
‡Mann-Whitney-U test.
BMI, body mass index; IQR, interquartile range; N/A, not applicable; OKS, Oxford Knee Score; PFJ, patellofemoral joint.

Table IV. Outcomes by subgroup.

Group	N	Median OKS (IQR)	Median AKSS-O (IQR)	Median AKSS-F (IQR)	Median Tegner Score (IQR)	Revised, % (n)	Five-year Kaplan-Meier survival (95% CI)
Age, yrs							
< 60	107	42 (34 to 47)	95 (84 to 100)	90 (70 to 100)	3 (3 to 4)	16 (17)	89.8 (84 to 96)
> 60	218	43 (37 to 47)	90 (83 to 99)	75 (64 to 90)	3 (2 to 3)	8 (17)	93.3 (90 to 97)
p-value	N/A	0.211*	0.033*	< 0.001*	< 0.001*	0.027†	0.098‡
Weight, kg							
< 82	173	43 (38 to 47)	95 (89 to 100)	80 (65 to 100)	3 (2 to 3)	9 (16)	93.5 (90 to 98)
> 82	131	43 (36 to 47)	95 (84 to 98)	80 (60 to 100)	3 (3 to 3)	12 (16)	91.0 (86 to 96)
p-value	N/A	0.275*	0.114*	0.967*	0.102*	0.519†	0.434‡
Tegner activity score							
< 5	276	43 (36 to 46)	95 (85 to 98)	75 (60 to 90)	3 (2 to 3)	10 (27)	92.4 (89 to 96)
> 5	35	47 (43 to 48)	97 (92 to 100)	100 (85 to 100)	6 (5 to 6)	14 (5)	93.8 (86 to 100)
p-value	N/A	< 0.001*	0.039*	< 0.001*	N/A	0.596†	0.558‡
PFJ							
No bone exposed	239	43 (37 to 46)	95 (87 to 98)	80 (60 to 100)	3 (2 to 3)	8 (20)	94.0 (91 to 97)
Bone exposed	46	43 (36 to 47)	95 (70 to 97)	75 (65 to 90)	3 (2 to 4)	11 (5)	92.7 (85 to 100)
p-value	N/A	0.852*	0.504*	0.610*	0.281*	0.804†	0.670‡

*Mann-Whitney U test.
†Chi-squared test.
‡Log rank test.
AKSS-O, American Knee Society Score Objective; AKSS-F, American Knee Society Score Functional; CI, confidence interval; IQR, interquartile range; OKS, Oxford Knee Score; PFJ, patellofemoral joint.

screw augmentation (n = 7; Figure 4), debridement (n = 1), exploration for pain (n = 1), or femoral component revision (n = 1). Single-stage TKA was the next most common secondary intervention (n = 11; seven primary TKA components; four unknown – performed elsewhere), followed by addition of medial UKA (n = 5; Figure 5), conversion to a fixed bearing tibial component (n = 1), and a two-stage TKA (n = 1; required revision components). Of the dislocations (n = 14), 12 (86%) were successfully managed with a single procedure with a mean follow-up of 4.2 years post-revision (1 to 10 years; bearing exchange (n = 5), bearing exchange and screw augmentation (n = 5), fixed bearing (n = 2)); the remaining cases (n = 2) suffered repeat dislocations and were converted to fixed-bearing tibial components at one month and three months after a bearing exchange and a bearing exchange with screw augmentation respectively.

Impact of historical UKA contraindications on outcome

Age. A total of 107 lateral UKAs (33%) were implanted in patients less than 60 years old. With the mean age for each group was 52 years (SD 6) and 71 years (SD 7), and older patients were more likely to be female (48% vs 69%; p < 0.001, chi-squared

Table V. Comparison of lateral unicompartmental knee arthroplasty series with greater than 50 patients.

Study	Region	N	Mean follow-up, yrs	Patient-time, component-yrs	Revisions, n (%)	CTIR* (revision)	Dislocation n (%)	CTIR* (dislocation)	Not dislocation, n (%)	CTIR* (not dislocation)	Ten-yr survival, %
Fixed-bearing											
Ashraf[32] 2002	UK	83	9	747	15 (18)	2.01	0	0	15 (18)	2.0	83
Berend[33] 2012	USA	100	3	204	1 (1)	0.49	0	0	1 (1)	0.3	N/A
Smith[34] 2014	UK	101	3	303	4 (4)	1.32	0	0	4 (4)	1.3	N/A
Edmiston[35] 2018	USA	65	7	455	4 (6)	0.88	0	0	4 (6)	0.9	80 to 85†
Oxford domed											
Newman[26] 2017	UK	61	7	427	7 (11)	1.64	1 (2)	0.23	6 (10)	1.41	80
Walker[14] 2018	Germany	363	3	1,089	36 (10)	3.31	20 (6)	1.84	16 (4)	1.47	N/A
This study	UK	325	7	2,324	34 (10)	1.46	14 (4)	0.60	20 (6)	0.86	85

*Calculated as event/patient-years.
†This study did not report their exact figure but displayed a survival curve.
CTIR, component time incidence rate; N/A, not available.

test; Table III). No difference in OKS or implant survival was found, but younger patients had slightly better median AKSS and Tegner scores (Table IV).

Weight. Weight was available in 304 knees (94%). There were 131 UKAs (43%) in patients over 82 kg in weight and the mean weights were 67 kg (48 to 82) and 95 kg (82 to 121) respectively. There were differences in age and percentage of females in the groups, with the heavier group being younger (mean age (yrs) 67 (SD 11) vs 61 (SD 10); $p < 0.001$, independent-samples *t*-test) and having a lower proportion of females (36% (47/131) vs 83% (144/173); $p < 0.001$, chi-squared test; Table III). There were no differences in outcome (Table IV).

Tegner. A Tegner score was available in 311 knees (96%). There were 35 UKAs (11%) in patients that had a Tegner score equal to or greater than five (participates in heavy labour, competitive cycling, or cross-country skiing). The median Tegner scores were 3 (IQR 2 to 3) and 6 (IQR 5 to 6). Those with high scores were younger (mean age 60 years (SD 11) vs 65 years (SD 11); $p = 0.009$, independent-samples *t*-test), a lower proportion were female (42% (15/35) vs 64% (178/276); $p = 0.013$, chi-squared test; Table III) and had a higher prevalence of full-thickness PFJ lesions (23% (8/35) vs 12% (32/276); $p = 0.027$, chi-squared test). Median OKS was 43 (IQR 36 to 46) vs 47 (IQR 43 to 48; $p < 0.001$, Mann-Whitney U test), and median AKSS-F was 75 (IQR 60 to 90) vs 100 (IQR 85 to 100; $p < 0.001$). There was no difference in implant survival ($p = 0.558$, log rank test).

Patellofemoral joint. Details on the state of the patellofemoral joint was available in 285 knees (88%). There were 46 UKAs (16%) in patients with full-thickness cartilage loss in the PFJ. This included any of the medial facet, lateral facet, or trochlea. There were no differences in baseline characteristics between groups (Table II), or outcome (Table IV).

Discussion

This is the largest series of lateral UKA with ten-year survival data and demonstrates that this prosthesis provides good results with high level of function, particularly in young patients. The survival rates, although satisfactory, are inferior to those achieved with medial UKA due to higher rates of bearing dislocation and arthritis progression.[24] Similar to medial mobile bearing UKA, previously proposed contraindications of age, weight, activity, and patellofemoral osteoarthritis[17,18] did not negatively affect patient-reported outcome measures (PROMs) or implant survival, so should not be considered contraindications.

Bearing dislocation has always been a problem with the mobile bearing OUKA in the lateral compartment due to the laxity of the lateral ligaments in flexion.[7] The Domed Lateral OUKA (Zimmer Biomet, Warsaw, Indiana, USA) was introduced to restore normal knee kinematics, particularly in high flexion, and reduce the risk of dislocation seen in earlier flat designs.[12] It has a spherically convex, domed tibial plateau, and a fully congruent biconcave bearing. This more closely mimics the normal anatomy than other knee replacements.[5] It also allows the lateral femoral condyle to sublux posteriorly and inferiorly, articulating with the posterior aspect of the convex lateral tibial plateau in high knee flexion, as it does in the normal knee. As a result it provides increased flexion and more normal roll back than the traditional flat design.[6,25] The biconcave-bearing has more entrapment than the flat-bearing making it is less likely to dislocate.[11] For an anterior or posterior dislocation the amount of distraction necessary for dislocation increases from 4.5 mm to 7.6 mm, and for medial dislocation onto the wall it increases from 4.1 mm to 5.9 mm.[11] This helps explain why domed lateral medial dislocation onto the wall occurs more frequently than anterior or posterior dislocation. It provides the rationale for inserting screws when treating this problem, so the heads sit above the wall and therefore increase the apparent height of the wall and prevent recurrent dislocation (Figure 4).

Despite the increased entrapment of the biconcave-bearing decreasing the likelihood of dislocation, the rate is still unacceptably high at 4% in the designer's series. Other series report dislocation rates of 2%, 2%, 4%, and 6%.[14,26-28] The Fixed bearing Lateral Oxford (FLO; Zimmer Biomet, Warsaw, Indiana, USA) tibial component was introduced, in part, to address this issue and was designed to be interchangeable with the domed lateral tibial component. The FLO does not have the advantages of minimal wear and improved kinematics of the domed but cannot dislocate. With the high dislocation rate reported in this study and the availability of the FLO, we have changed our practice and recommend that surgeons implanting the domed lateral component should assess the bearing stability during the trialling phase of the operation with the knee in a figure of four position. If it is found that the trial bearing, held in the bearing removal instrument, can easily be dislocated medially onto the wall, we recommend implanting the FLO

tibial component. Furthermore if dislocation of the domed lateral bearing does subsequently occur, this can be treated with conversion to a FLO.

There is marked variability in the results of lateral UKA, as shown in Table V. The ten-year survival of the domed lateral OUKA is 85% in this study. This is comparable to three other studies reporting the ten-year survival of lateral UKA, two of which were fixed-bearing and one mobile. If the risk of dislocation could be decreased, then the ten-year survival would increase to 90%, which would be better than that reported by other studies of lateral UKA, but would still remain inferior to that achieved by medial OUKA (94% to 99%[24,29,30]). The main reason for this difference is that revision for progression of disease medially after lateral UKA (7.7% at ten years in this study) is much more common than revision for progression of disease laterally after medial UKA.[24] It is not clear why this is and further study is needed to understand the risk factors for medial disease progression after lateral UKA. It is, however, interesting to note that disease progression, particularly medially, is even more common after patellofemoral arthroplasty.[31]

TKA is an alternative option for patients with lateral disease and while this would reduce the revision rate for dislocation, it would remove many advantages provided by UKA. UKA has fewer perioperative complications, and a lower mortality rate than TKA.[36] Following domed lateral UKA knee movement is similar to the native knee,[25] unlike following TKA.[37,38] The mean OKS in this series of domed lateral UKA was 40 (SD 9; 6 to 48), which is higher than the OKS usually achieved by TKA.[39,40] Further, valgus knees undergoing TKA have double the revision rate of those in varus,[41,42] making lateral UKA an attractive alternative.

The indications for medial UKA are now established and evidence-based.[15,16,43] These are bone-on-bone arthritis of the affected compartment, full thickness cartilage in the other compartment, and functionally intact ligaments. Evidence supporting lateral UKA has lagged behind the medial UKA as fewer than 5% of patients with knee arthritis have isolated lateral osteoarthritis, compared to 30% to 50% having isolated medial compartment osteoarthritis.[44] Consequently, indications for the procedure have reflected the medial side. The contraindications proposed by Kozinn and Scott[17] for fixed bearing UKA, such as young age, heavy weight, high activity, or coexistent patellofemoral osteoarthritis, were found not to compromise the outcome of the medial OUKA.[16-18] Therefore they have not been contraindications to medial OUKA and it was assumed that they should not be contraindications to lateral OUKA. This study found that patient function and implant survival following dome lateral OUKA were not compromised by these proposed contraindications, confirming that they should not apply to the dome lateral UKA.

Our study has limitations. These results were obtained by the designer surgeons, which may limit the generalizability of the results. However, other centres have reported similar results with similar dislocation rates.[14,25-27] Additionally, we did not undertake a radiological review, however, it is function and survival that are the most important outcomes.

In conclusion, the Oxford domed lateral UKA provides a good treatment option for lateral compartment osteoarthritis. Young age, heavy weight, high activity, and coexistent patellofemoral osteoarthritis should not be considered contraindications. There is an appreciable risk of bearing dislocation and if the bearing is found to be unstable at surgery, it may be sensible to implant the FLO tibial component, which is interchangeable with the dome lateral component.

Take home message

- The domed lateral mobile bearing UKA provides good outcomes in the treatment of lateral compartment osteoarthritis.
- The risk of dislocation in this study is 4%. To prevent dislocation, intraoperative trialling to assess the stability of the bearing is recommended. If unstable, a Fixed Lateral Oxford (FLO) tibial component should be implanted.

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