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Lateral and patellofemoral compartment osteoarthritis progression after medial unicompartmental knee arthroplasty: A five- to 10-year follow-up study

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Background: The purpose of the study was to evaluate lateral and patellofemoral osteoarthritis (OA) progression after medial unicompartmental knee arthroplasty (UKA) and identify factors affecting the progression that were not identified previously.

Methods: We evaluated 146 patients who underwent medial UKA between 2009 and 2014. Kellgren–Lawrence grading of lateral and patellofemoral OA was performed on preoperative and final follow-up knee radiographs. Radiographic and clinical characteristics, SF-36, and Oxford knee scores were compared between the OA progressed and non-progressed groups. Risk factors for lateral and patellofemoral OA progression were evaluated.

Results: The lateral OA progressed and non-progressed groups significantly differed in side, preoperative flexion contracture, preoperative joint line convergence angle, postoperative tibiofemoral angle, insert size, revision status ($P < 0.05$), and the patellofemoral OA progressed and non-progressed groups significantly differed in age, pre- and postoperative flexion contracture, postoperative tibiofemoral angle and pre- and postoperative patellofemoral OA grade ($P < 0.05$). At the final follow-up, Visual Analogue Scale, Oxford Knee Scores, and SF-36 subscores were significantly better in the lateral OA non-progressed group ($P < 0.001$).
Dominant leg (odds ratio (OR): 2.759), insert size (>4, OR: 2.219), revision status (+, OR: 6.692), and postoperative tibiofemoral angle (>5.5°, OR: 1.177) were independent risk factors for lateral OA progression, whereas age (>60 years, OR: 3.222), preoperative patellofemoral OA grade (>1, OR: 2.085), and postoperative flexion contracture (>10°, OR: 1.919) were those for patellofemoral OA progression.

Conclusions: Mild radiographic progression of 1 KL grade is frequently seen five to 10 years after medial UKA. Postoperative outcomes are significantly affected by lateral compartment OA progression but not by patellofemoral OA progression.

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1. Introduction

Medial unicompartmental knee arthroplasty (UKA) is a widely accepted surgical treatment for medial knee osteoarthritis (OA) and osteonecrosis [1]. Good to excellent outcomes with 10- to 15-year high survival rates have been reported [2–4].

OA progression in the lateral and patellofemoral compartments is the second most common cause for failure following femoral and tibial component loosening [5]. However, failure after UKA is most often seen in the first five years after surgery because of improper indications and surgical errors [6].

OA may develop or progress in the lateral compartment in the postoperative mid- and long-term. Lateral OA is a contraindication to medial UKA [6] and may adversely affect the outcomes and cause need for revision. Therefore, understanding the factors affecting OA progression will help in improving functional outcomes after medial UKA and reduce revision rates. Previously, overcorrection of the varus deformity in anteromedial OA was associated with lateral compartment overload and OA progression [7]. Recently, factors associated with lateral OA have been investigated, and condition of the lateral compartment and existence of systemic inflammatory disease were found to be associated with postoperative OA progression [8,9].

Anterior knee pain and patellofemoral OA are common in patients aged >50 years [10]. Despite the fact that they were previously accepted as contraindications for medial UKA, recent short-term studies reported few revisions because of patellofemoral OA and good to excellent outcomes in the first 10 years postoperatively [11–13]. Oversized femoral components with possible impingement on the patellar cartilage were thought to be associated with OA progression in the patellofemoral joint after UKA [14].

To the best of our knowledge, no studies have comprehensively evaluated mid-term outcomes of patients with and without OA progression as well as factors affecting lateral and patellofemoral OA progression five to 10 years postoperatively.

Therefore, the aims of this study were to: (1) compare the outcomes of patients with lateral and patellofemoral OA progression and non-progression; (2) define factors affecting lateral and patellofemoral OA progression; and (3) determine correlations between lateral and patellofemoral OA progression.

2. Materials and methods

2.1. Statement of ethics

The study was approved by the Local Ethics Committee of Health Sciences University Kayseri City Training and Research Hospital (protocol no: 76397871–20/15.11.18).

2.2. Patient selection

Between 2009 and 2014, the senior author performed 226 Oxford Phase III mobile-bearing medial UKAs. Of these, we retrospectively collected data from 146 medial UKAs with a history of medial compartmental OA (139 knees) and avascular necrosis (seven knees). UKA indications were as follows: unicondylar OA (mild to moderate patellofemoral OA was not a contraindication) or osteonecrosis that significantly affected the daily activities of the patient or pain at rest, coronal plane deformity <15°, flexion contracture <15°, intact anterior cruciate ligament, absence of inflammatory arthritis, healthy lateral compartment cartilage, body mass index (BMI) <35 kg/m^2 and age >55 years.

Exclusion criteria were those of patients who had undergone previous surgery (i.e. anterior cruciate ligament reconstruction, high tibial osteotomy, distal femoral osteotomy, and cartilage restoration surgery in the lateral compartment due to full-thickness cartilage defects); those with inflammatory arthritis, valgus malalignment of >5°, varus malalignment of >10° (these patients underwent corrective distal femoral or proximal tibial osteotomy prior to UKA), and active range of motion of <90°; and those with functionally impaired anterior cruciate ligament or any collateral ligament of the knee. Informed consent was obtained from all participants.

2.3. Radiologic evaluation and outcome measures

Patient and clinical characteristics, preoperative and the last follow-up radiographs, Short Form-36 (SF-36) health-related quality of life questionnaire, and Oxford Knee Scores were evaluated. Preoperative and immediate postoperative knee range of motion (flexion and extension) and loss of knee extension were measured using a long arm goniometer. Leg dominancy has been defined as the leg that the individual used in order to move or manipulate an object [15]. To determine the dominant leg, a previously identified and accepted 'which leg would you use if you shoot a ball on a target?' question was asked to patients [16].

Radiological analysis was performed at the preoperative, immediate postoperative and at the last follow-up where OA progression was first seen, with a focus on arthritis progression in the lateral and patellofemoral compartments according to the Kellgren–Lawrence (KL) OA grading system [17] using weight-bearing anteroposterior and lateral radiographs, and skyline views. Lateral and patellofemoral OA progression was defined as at least 1 grade increase in the KL OA grading system. In addition, changes in the preoperative versus postoperative measurements of the joint line convergence angle (JLCA) of the operated and contralateral knees, tibiofemoral coronal angle, and tibial slope angle were measured twice by two examiners who were blinded to the study protocol, 30 days apart. Patients were divided into the following groups: the lateral OA progressed and non-progressed groups and the patellofemoral OA progressed and non-progressed groups. The KL OA grading system was used to evaluate OA progression on the immediate preoperative and the final follow-up radiographs.

2.4. Surgical technique

Primary UKAs were performed using the Oxford Phase III mobile-bearing prosthesis (Zimmer Biomet, Warsaw, IN, USA) in all consecutive cases. Surgery was performed using a medial parapatellar approach without patellar dislocation. Components were fixed with or without cement. Immediate full weight-bearing with crutches and active knee flexion and extension exercises were started postoperatively.

2.5. Statistical analysis

The distribution of variables was measured using the Kolmogorov–Smirnov test. Mean ± standard deviation, median, minimum and maximum values, and frequency ratios were used for descriptive statistics of data. The independent sample *t*-test and Mann–Whitney *U*-test were used to analyze independent quantitative data. Wilcoxon test was used to analyze dependent quantitative data. Chi-squared test was used to analyze qualitative independent data, and Fisher's exact test was used when the chi-squared test requirements were not met. The Pearson correlation analysis test was used to evaluate correlation between lateral and patellofemoral OA progression. The intraclass correlation coefficient (ICC) with a 95% confidence interval was used to quantify agreement between measurement parameters and OA progression decision among the reviewers. On the basis of Landis and Koch's study [18], we defined 0–0.2 as slight agreement, 0.21–0.40 as fair agreement, 0.41–0.60 as moderate, 0.61–0.8 as substantial, and values >0.81 as perfect agreement in the ICC evaluations. Binary logistic regression analysis was performed to evaluate independent risk factors for lateral and patellofemoral OA progression. A *P*-value of <0.05 was considered significant. All statistical analyses were performed using SPSS v22.0 for Windows (SPSS Inc., IL, USA).

3. Results

The mean age of patients was 58.8 ± 7.0 years, and the mean follow-up duration was 7.41 ± 1.54 years (range, five to 10 years). There were 15 men and 131 women. Patient characteristics and demographic data are summarized in Tables 1 and 3.

Preoperative and postoperative median KL OA grades in the lateral compartment were 0 (range, 0–1) and 2 (range, 1–4), respectively. Preoperative and postoperative median KL grades for patellofemoral OA were 1 (range, 0–2) and 3 (range, 2–4), respectively.

Lateral OA progression developed in 51 of 146 patients (34.9%). OA progression in the patellofemoral compartment developed in 66 of 146 patients (45.2%) ($P = 0.176$) and that in both the lateral and patellofemoral compartments was observed in 26 (17.8%) patients. Perfect intra- and interobserver agreement was observed in all measurement parameters and OA progression decisions (ICC >0.816 and >0.843, respectively).

Table 1
Comparative parameters of the patients with and without lateral compartment osteoarthritis (OA) progression.

	All patients (n = 146) Mean ± SD/%/median (range)	Lateral OA progressed (n = 51) Mean ± SD/%/median (range)	Lateral OA non-progressed (n = 95) Mean ± SD/%/median (range)	*P*
Age (years)	58.8 ± 7.0	58.5 ± 6.0	58.9 ± 7.5	0.652
Sex				
Female	131 (89.7%)	44 (86.2%)	87 (91.6%)	0.491
Male	15 (10.3%)	7 (13.8%)	8 (8.4%)	
BMI (kg/m^2)	29.1 ± 2.7	28.7 ± 3.9	29.4 ± 2.6	0.120
Side				
Right	67 (45.9%)	39 (76.4%)	28 (29.5%)	**0.034**
Left	48 (32.9%)	9 (17.6%)	39 (41%)	
Bilateral	31 (21.2%)	3 (6%)	28 (29.5%)	
Preoperative flexion contracture (°)	7.3 ± 3.6	9.3 ± 3.4	5.6 ± 4.9	**0.005**
Postoperative flexion contracture (°)	6.1 ± 6.4	7.6 ± 4.1	5.3 ± 2.9	0.096
Preoperative JLCA (°)	−3.4 ± 1.8	−3.7 ± 1.7	−3.3 ± 1.8	**0.001**
Postoperative JLCA (°)	1.3 ± 1.3	1.4 ± 1.4	1.2 ± 1.1	0.371
Preoperative tibiofemoral angle (°)	−1.8 ± 2.2	−1.7 ± 2.2	−1.9 ± 2.1	0.094
Postoperative tibiofemoral angle (°)	4.7 ± 2.6	5.8 ± 2.4	2.2 ± 3.1	**0.009**
Insert size	3.0 (3–6)	4 (3–6)	3 (3–6)	**0.024**
Contralateral knee OA progression				
Yes	68 (46.6%)	37 (72.5%)	31 (32.6%)	**0.001**
No	78 (53.4%)	14 (27.5%)	64 (67.4%)	
Preoperative tibial slope (°)	10.4 ± 2.0	10.0 ± 2.0	10.6 ± 1.9	0.052
Postoperative tibial slope (°)	7.0 ± 1.2	6.8 ± 1.9	7.1 ± 1.7	0.412
Revision status	10 (6.9%)	7 (70%)	3 (30%)	**0.000**

BMI, body mass index; JLCA, joint line convergence angle; SD, standard deviation.
Bold values indicate statistical significance.

There were significant differences between the lateral OA progressed and non-progressed groups in terms of side ($P = 0.034$), preoperative flexion contracture ($P = 0.001$), preoperative JLCA ($P = 0.001$), postoperative tibiofemoral angle ($P = 0.009$), insert size ($P = 0.024$), revision status ($P < 0.001$), contralateral knee OA progression ($P = 0.001$), postoperative Visual Analogue Scale (VAS) scores ($P < 0.001$), postoperative Oxford Knee Scores ($P < 0.001$), and postoperative all SF-36 sub-scores ($P < 0.05$ for all) (Tables 1 and 2). Similarly, there were significant differences between the patellofemoral OA progressed and non-progressed groups with respect to age ($P < 0.001$), preoperative and postoperative flexion contracture ($P = 0.012$ and $P = 0.036$), postoperative tibiofemoral angle ($P = 0.009$) and preoperative and postoperative patellofemoral OA grade ($P = 0.029$ and 0.003, respectively), (Table 3). However, postoperative VAS scores ($P = 0.101$), postoperative Oxford Knee Scores ($P = 0.213$), and postoperative SF-36 sub-scores were not significantly different between patellofemoral OA progressed and non-progressed groups ($P > 0.05$ for all) (Table 4).

In the multivariate analysis, dominant leg ($P = 0.043$, odds ratio (OR): 2.759), insert size (>4) ($P = 0.006$, OR: 2.219), revision status (+) ($P = 0.007$, OR: 6.692), and postoperative tibiofemoral angle (>5.5°) ($P = 0.004$, OR: 1.177) were found to be independent risk factors for lateral OA progression, whereas age (>60) ($P < 0.001$, OR: 3.222), preoperative patellofemoral OA grade (>1) ($P = 0.017$, OR: 2.085), and postoperative flexion contracture (>10°) ($P = 0.009$, OR: 1.919) were those for patellofemoral OA progression (Table 5).

There were no significant correlations between lateral and patellofemoral OA progression ($P = 0.753$).

Of the 51 lateral compartment OA progression patients, 37 (72.6%) had one grade progression and 14 (27.4%) had two or more grade progressions. Twelve patients (32.5%) with one grade progression were symptomatic. Revision surgery was not needed in any of the patients due to OA progression. Conversely, all of the two or more grade progression knees were symptomatic (mostly mild to moderate). Only one patient (7.2%) underwent revision surgery (UKA to total knee arthroplasty (TKA)). Also, of the 66 patellofemoral compartment OA progression patients, 29 (43.9%) had one grade progression and 35 (56.1%) had two or more grade progressions. In one grade progression group, all patients had mild symptoms. However, all of the two or more grade progression knees had moderate symptoms. None of the patients needed a revision due to arthritis progression (Figures 1 and 2).

During the follow-up period, 10 knees (10 patients) underwent revision. The reason for revision was insert dislocation in nine patients (90%) and lateral compartment OA in one patient (10%). TKA was performed in five patients. One TKA was due to the progression of OA in the lateral compartment. Insert dislocations (five patients) were revised by exchanging the previous insert with a thicker one. Medial collateral ligament rupture was observed in one patient, and anterior cruciate ligament rupture was observed in one patient. Implant loosening was not observed in any of patients.

Table 2
Pre- and postoperative visual analogue scale (VAS), Oxford Knee Score and Short Form-36 (SF-36) scores in patients with and without lateral compartment osteoarthritis (OA) progression.

		Total	Lateral OA progressed (n = 51)	Lateral OA non-progressed (n = 95)	*P*
VAS score	Preoperative	8.6 ± 0.9	8.6 ± 0.8	8.6 ± 0.9	0.994
	Postoperative	2.5 ± 1.8	3.6 ± 2.0	1.9 ± 1.3	<**0.001**
	P	<**0.001**	<**0.001**	<**0.001**	
Oxford Knee Score	Preoperative	24.0 ± 5.8	24.4 ± 6.8	23.7 ± 5.2	0.526
	Postoperative	35.7 ± 6.7	31.0 ± 7.5	38.8 ± 5.2	<**0.001**
	P	**0.001**	**0.024**	**0.001**	
SF-36 Physical functioning	Preoperative	37.9 ± 11.9	38.6 ± 12.8	37.5 ± 11.3	0.592
	Postoperative	75.3 ± 15.0	65.7 ± 16.5	80.5 ± 11.0	<**0.001**
	P	<**0.001**	**0.001**	<**0.001**	
SF-36 Bodily pain	Preoperative	77.9 ± 13.8	77.0 ± 15.1	78.3 ± 13.0	0.604
	Postoperative	38.4 ± 17.4	47.2 ± 17.2	33.6 ± 15.6	<**0.001**
	P	<**0.001**	**0.037**	<**0.001**	
SF-36 Physical role	Preoperative	26.4 ± 18.7	33.4 ± 17.8	22.6 ± 18.2	<**0.001**
	Postoperative	72.9 ± 15.9	64.2 ± 16.7	77.6 ± 13.4	<**0.001**
	P	<**0.001**	<**0.001**	**0** < **0.001**	
SF-36 General health	Preoperative	38.4 ± 11.2	38.7 ± 12.8	38.2 ± 10.3	0.806
	Postoperative	66.0 ± 16.6	59.1 ± 16.6	69.7 ± 15.4	<**0.001**
	P	<**0.001**	**0.019**	<**0.001**	
SF-36 Vitality	Preoperative	33.5 ± 10.9	32.8 ± 11.6	33.9 ± 10.6	0.558
	Postoperative	76.9 ± 14.6	69.1 ± 16.3	81.1 ± 11.7	<**0.001**
	P	**0.001**	**0.003**	<**0.001**	
SF-36 Social role	Preoperative	79.8 ± 17.7	77.4 ± 20.0	81.0 ± 16.3	0.273
	Postoperative	30.7 ± 23.4	48.5 ± 24.3	21.1 ± 16.4	<**0.001**
	P	<**0.001**	**0.009**	<**0.001**	
SF-36 Emotional role	Preoperative	8.4 ± 16.5	9.2 ± 17.7	8.1 ± 15.9	0.717
	Postoperative	81.9 ± 28.3	64.0 ± 35.8	91.6 ± 16.8	<**0.001**
	P	<**0.001**	<**0.001**	<**0.001**	
SF-36 Mental health	Preoperative	45.8 ± 18.9	44.6 ± 18.8	46.4 ± 19.0	0.589
	Postoperative	54.0 ± 21.1	40.4 ± 21.0	61.3 ± 17.4	<**0.001**
	P	0.393	0.320	0.127	

Table 3
Comparative parameters of the patients with and without patellofemoral (PF) compartment osteoarthritis (OA) progression.

	All patients (n = 146) Mean ± SD/%/median (range)	Patellofemoral OA progressed (n = 66) Mean ± SD/%/median(range)	Patellofemoral OA non-progressed (n = 80) Mean ± SD/%/median(range)	*P*
Age (years)	58.8 ± 7.0	63.4 ± 6.3	55.9 ± 4.8	<**0.001**
Sex				
Female	131 (89.7%)	60 (90.1%)	71 (88.7%)	0.890
Male	15 (10.3%)	6 (9.9%)	9 (11.3%)	
BMI (kg/m^2)	29.1 ± 2.7	28.9 ± 3.5	29.4 ± 3.1	0.367
Side				
Right	67 (45.9%)	37 (56.1%)	30 (37.5%)	0.756
Left	48 (32.9%)	19 (28.7%)	29 (36.3%)	
Bilateral	31 (21.2%)	10 (15.2%)	21 (26.2%)	
Preoperative flexion contracture (°)	6.3 ± 3.6	8.6 ± 5.5	4.3 ± 5.2	**0.012**
Postoperative flexion contracture (°)	6.1 ± 6.4	8.3 ± 4.1	4.5 ± 5.2	**0.036**
Preoperative JLCA (°)	−3.4 ± 1.8	−3.2 ± 1.6	−3.6 ± 1.9	0.276
Postoperative JLCA (°)	1.3 ± 1.3	1.1 ± 1.2	1.4 ± 1.3	0.234
Preoperative tibiofemoral angle (°)	−1.8 ± 2.2	−1.7 ± 2.1	−1.9 ± 2.2	0.785
Postoperative tibiofemoral angle (°)	4.7 ± 2.6	5.9 ± 3.4	3.8 ± 2.1	**0.009**
Insert size	3 (3–6)	3 (3–6)	3 (3–6)	0.597
Preoperative tibial slope (°)	10.4 ± 2.0	10.6 ± 1.8	10.3 ± 2.1	0.476
Postoperative tibial slope (°)	7.0 ± 1.2	7.2 ± 2.0	6.9 ± 1.6	0.284
Contralateral knee OA progression				
Yes	68 (46.6%)	49 (55.7%)	32 (55.1%)	0.819
No	78 (53.4%)	39 (44.3%)	26 (44.9%)	
Preoperative PF compartment KL OA degree	1 (0–2)	2 (0–3)	1 (0–2)	**0.029**
Postoperative PF compartment KL OA degree	3 (2–4)	3 (1–4)	2 (0–2)	**0.003**

BMI, body mass index; JLCA, joint line convergence angle; KL, Kellgren–Lawrence.

Table 4
Pre- and postoperative visual analogue scale (VAS), Oxford Knee Score and Short Form-36 (SF-36) scores in patients with and without patellofemoral compartment osteoarthritis (OA) progression.

		Total	Patellofemoral OA progressed	Patellofemoral OA non-progressed	*P*
VAS score	Preoperative	8.6 ± 0.9	8.5 ± 0.8	8.6 ± 0.8	0.947
	Postoperative	2.5 ± 1.8	2.8 ± 1.7	2.1 ± 1.8	0.101
	P	<**0.001**	<**0.001**	<**0.001**	
Oxford knee score	Preoperative	24.0 ± 5.8	24.9 ± 6.5	23.2 ± 5.1	0.087
	Postoperative	35.7 ± 6.7	35.0 ± 6.8	36.4 ± 6.5	0.213
	P	**0.001**	**0.005**	<**0.001**	
SF-36 Physical functioning	Preoperative	37.9 ± 11.9	40.0 ± 12.7	36.0 ± 10.8	0.055
	Postoperative	75.3 ± 15.0	74.1 ± 15.6	76.4 ± 14.3	0.364
	P	<**0.001**	**0.001**	<**0.001**	
SF-36 Bodily pain	Preoperative	77.9 ± 13.8	76.2 ± 14.4	79.1 ± 13.1	0.216
	Postoperative	38.4 ± 17.4	39.2 ± 18.5	37.6 ± 16.5	0.566
	P	<**0.001**	<**0.001**	<**0.001**	
SF-36 Physical role	Preoperative	26.4 ± 18.7	25.4 ± 19.8	27.2 ± 17.8	0.568
	Postoperative	72.9 ± 15.9	71.6 ± 14.4	74.1 ± 17.0	0.346
	P	<**0.001**	<**0.001**	<**0.001**	
SF-36 General health	Preoperative	38.4 ± 11.2	38.5 ± 9.5	38.3 ± 12.5	0.925
	Postoperative	66.0 ± 16.6	65.8 ± 15.0	66.1 ± 17.8	0.292
	P	<**0.001**	<**0.001**	<**0.001**	
SF-36 Vitality	Preoperative	33.5 ± 10.9	34.5 ± 11.6	32.7 ± 10.2	0.235
	Postoperative	76.9 ± 14.6	75.5 ± 16.1	78.1 ± 13.2	0.109
	P	**0.001**	**0.003**	<**0.001**	
SF-36 Social role	Preoperative	79.8 ± 17.7	80.5 ± 15.3	79.2 ± 19.5	0.667
	Postoperative	30.7 ± 23.4	30.6 ± 23.9	30.7 ± 23.1	0.980
	P	<**0.001**	<**0.001**	<**0.001**	
SF-36 Emotional role	Preoperative	8.4 ± 16.5	8.1 ± 15.5	8.7 ± 17.3	0.706
	Postoperative	81.9 ± 28.3	80.8 ± 30.9	82.9 ± 26.0	0.662
	P	<**0.001**	<**0.001**	<**0.001**	
SF-36 Mental health	Preoperative	45.8 ± 18.9	45.0 ± 18.6	46.5 ± 19.2	0.621
	Postoperative	54.0 ± 21.1	52.4 ± 19.6	55.3 ± 22.3	0.392
	P	0.393	0.468	0.128	

Table 5
Independent risk factors for Lateral and patellofemoral (PF) compartment osteoarthritis (OA) progression.

		Odds ratio	*P*
Lateral OA progression	Dominant leg	2.759	**0.043**
	Insert size (>size 4)	2.219	**0.006**
	Revision status (+)	6.692	**0.007**
	Postoperative tibiofemoral angle (>5.5°)	1.177	**0.004**
Patellofemoral OA progression	Age (>60 years)	3.222	<**0.001**
	Preoperative PF OA grade (>grade 1)	2.085	**0.017**
	Postoperative flexion contracture (>10°)	1.919	**0.009**

4. Discussion

The most important findings of this study were that OA progression was more frequent in the patellofemoral compartment than in the lateral compartment. No correlation was found in OA progression between the lateral and patellofemoral compartments. Distinct factors associated with OA progression in the lateral and patellofemoral compartments were identified for the first time. Dominant leg, insert size, revision status, and postoperative tibiofemoral angle were independent risk factors for lateral OA progression. Age, preoperative patellofemoral OA grade, and postoperative flexion contracture were those for patellofemoral OA progression.

Survivorship of medial UKA in the mid- and long-term has been reported in various studies [19]. Failure and revision requirement are observed mostly during the postoperative first five years on account of technical problems and incorrect indications [6]. These factors are dependent on the surgeon. Bearing dislocation, mechanical loosening, lateral OA progression, and unexplained pain (particularly anterior knee pain) are other mechanisms of failure and revision in mobile-bearing UKA in the mid- and long-term that are predominantly independent of the surgeon or surgical technique [6,20–23]. Choosing overcorrection so as to avoid bearing dislocation in mobile-bearing UKA has been associated with lateral OA progression. Because of valgus overloading and tight knee joints, there is greater contact stress exposure on the lateral compartment, and this overloading predisposes the patient to OA progression [24]. We found higher lateral OA progression in patients with more varus correction. In our five- to 10-year follow-up study, 34.9% of patients had lateral OA progression, 45.2% had patellofemoral OA progression, and 17.8% had both lateral and patellofemoral OA progression. However, 10 patients underwent revision surgery: due to bearing dislocation in nine (90%) and lateral OA progression in one (10%). In addition to radiographic outcomes, OA-progressed patients had significantly worse VAS scores, Oxford Knee Scores, and SF-36 scores than did OA non-progressed patients. Despite revision due to OA progression being performed in very few patients in the mid-term follow-up, increase in the number of patients undergoing OA progression and associated need for revision may be required in the long-term follow-up.

Previously, causes of lateral OA progression have been evaluated. Murray et al. [25] suggested that lateral compartment OA progression is caused by overcorrection of the varus deformity and associated overloading of the lateral compartment. In contrast, Pandit et al. [7] reported that the condition of the lateral compartment at the immediate postoperative radiograph is a significant predictor for OA development. They found no causal relationship between OA progression and BMI, postoperative leg alignment, meniscal bearing size, and presence of chondrocalcinosis. JLCA may represent contracture or laxity in soft tissues around the knee joint [26]. Articular cartilage pressure distribution can be affected by that [27]. Therefore, it may lead to postoperative OA progression. In the present study, we found significant differences between the OA progressed and non-progressed patients with respect to insert size, preoperative JLCA, and postoperative tibiofibular angle parameters. Furthermore, dominant leg, higher insert size, immediate postoperative lateral OA grade >0, history of revision, and increased postoperative tibiofibular angle were identified

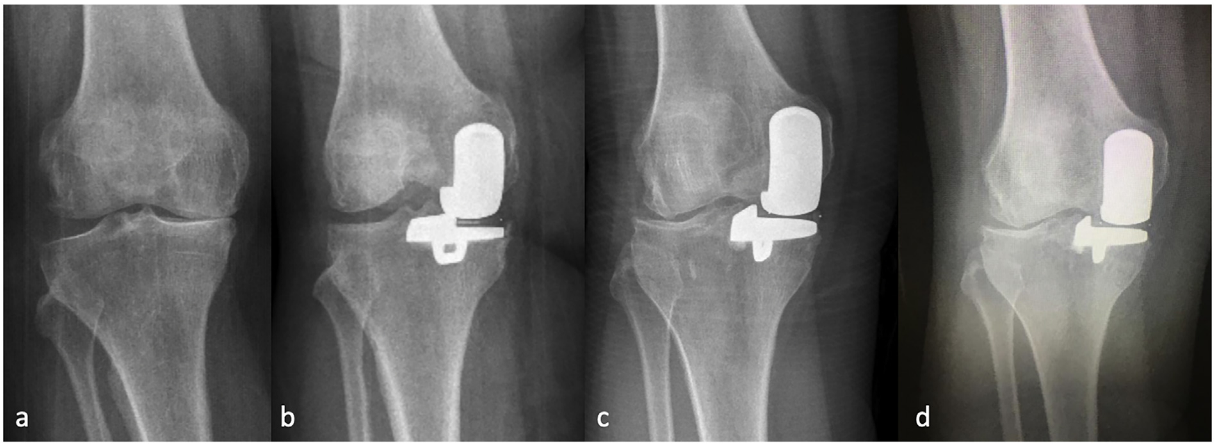

Figure 1. Lateral compartment osteoarthritis progression in a 64-year-old patient. (a) Preoperative, (b) postoperative one-year, (c) postoperative four-year, and (d) postoperative six-year follow-up radiographs.

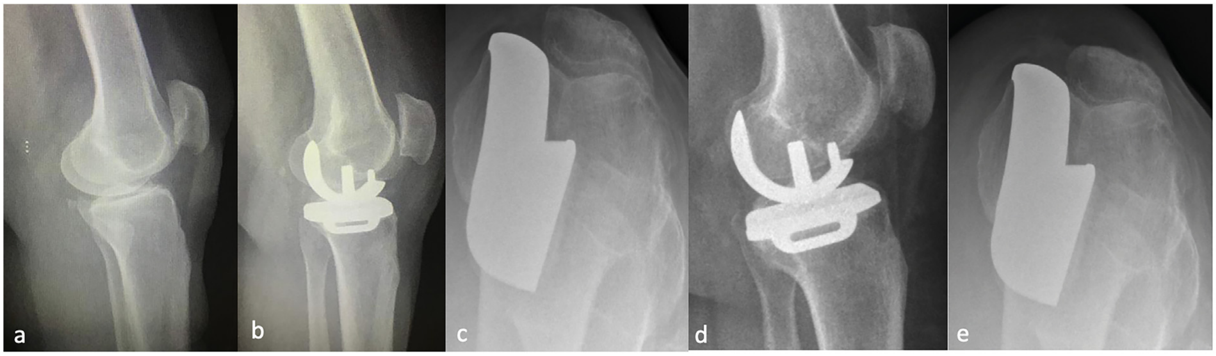

Figure 2. Patellofemoral compartment osteoarthritis progression in a 56-year-old patient. (a) Preoperative, (b, c) postoperative one-year, (d, e) postoperative five-year follow-up radiographs.

as independent risk factors for lateral OA progression. Causal relationship between lateral compartment OA progression and the factors we identified may be attributed to (1) increased postoperative activity level in the dominant leg compared with the non-dominant leg, (2) changed soft tissue balance, JLCA and associated lateral compartment pressure distribution due to thicker insert placement [28], or revision with a thicker insert, (3) present degeneration shows faster OA progression than healthy cartilage [29] and, (4) greater contact stress exposure on the lateral compartment due to more varus correction [24].

Anterior knee pain and moderate degenerative changes in the patellofemoral joint are not absolute contraindications to UKA [1]. Centering of the patellofemoral joint (PFJ) after UKA can reduce stress in the PFJ and related anterior knee pain [30]. Severe degenerative changes in the lateral patellar facet are not accepted as suitable conditions for UKA. However, less severe degeneration in the lateral patellar facet is not considered a contraindication to UKA, even in the presence of severe medial facet degeneration [13]. Therefore, the presence of osteoarthritic changes in the patellofemoral joint, as opposed to that in the lateral compartment, is not a contraindication to UKA [13]. In addition, few revisions were reported due to patellofemoral OA progression [4,31–33]. This was associated with the anatomical design of Oxford UKA, which avoids overloading of the patellofemoral joint [34]. Although patellofemoral OA progression is a rare cause of revision, it is functionally disadvantageous, especially for stair descent [13]. In the present study, we found no significantly different VAS, Oxford Knee, and SF-36 scores between the patellofemoral OA progressed and non-progressed patients. To the best of our knowledge, no study has comprehensively evaluated factors affecting patellofemoral OA progression after UKA. In the present study, we found significant differences between the patellofemoral joint OA progressed and non-progressed patients with respect to age, preoperative patellofemoral OA grade, preoperative and postoperative flexion contracture, and postoperative tibiofemoral angle. Furthermore, older age, higher preoperative patellofemoral OA grade, and higher postoperative flexion contracture were identified as independent risk factors for patellofemoral OA progression. Causal relationship between patellofemoral compartment OA progression and the factors we identified may be attributed to (1) faster degeneration of joint cartilages with age [35], (2) existing degeneration showing faster OA progression than healthy cartilage [36] and, (3) increased patellofemoral joint loading during walking in knees with flexion contracture [37].

Lateral patellofemoral OA is associated with patellofemoral dysplasia or valgus knee, whereas medial patellofemoral OA is associated with varus knee [6]. Worse VAS, Oxford Knee, and SF-36 scores in the patellofemoral OA progressed patients in our study may be associated with preoperative varus to postoperative valgus alignment change and lateral facet degeneration.

There are several limitations to our study. First, this study was retrospective in nature, despite us having used prospectively collected data of patients not lost to follow-up to achieve more accurate results. Second, this study had a relatively small sample size. Third, the study had a relatively short follow-up period following the surgical procedures. Long-term functional and radiologic outcomes may differ. Fourth, insert size can be a marker for over-stuffing and over-correction, but it can also be the reflection of the depth of the tibial cut [38]. Due to not measuring the depth of the tibial cut, it can be defined as a surrogate marker. Fifth, pre- to postoperative angle changes can be affected by the severity of hip OA and malalignment [39]. Long-leg alignment radiographs were not performed in our study. Focusing on the over-correction of alignment would be more relevant if the measurements could have been performed on long-leg alignment radiographs. Sixth, our definition of progression as 1 KL grade was quite strict. In most of the patients, it was not clinically significant. Clinically significant correlations would be observed with a larger KL grade definition of progression and higher number of patients. Finally, although commenting on the contralateral leg OA status may be relevant, depending on the timing of the radiographs, it may not be possible to differentiate them from more generalized OA patients or an older population group. Despite these limitations, results of the present study might be useful to identify appropriate patients and treatment options for unicompartmental knee OA, carefully considering patient factors and functional and radiologic evaluations.

5. Conclusion

Mild radiographic progression of 1 KL grade is frequently seen five to 10 years after medial UKA. Postoperative pain and outcome scores are significantly affected by lateral compartment OA progression but not by patellofemoral OA progression.

Independent risk factors identified in this study may help surgeons to select appropriate treatments for medial compartmental OA so as to achieve long-term success and patient satisfaction.

Declaration of competing interest

The authors have no conflicts of interest to declare.

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