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Patella Cartilage Status Does Not Affect the Clinical Outcomes of Non-resurfaced Patella in Mobile-Bearing Total Knee Arthroplasty

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Background: During total knee arthroplasty (TKA), patellar retention is performed when the cartilage is fairly well preserved and the thickness of the patella is relatively thin. However, clinical outcomes of the non-resurfaced patella in TKA according to the cartilage status are lacking in the literature. The purpose of this study was to compare patient-reported outcome measures (PROMs) according to the grade and location of the patellar cartilage lesion in TKA patients.

Methods: The outcomes of 165 osteoarthritis patients (186 knees) who underwent cemented mobile-bearing TKA without patellar resurfacing were assessed and classified according to the grade and location of the patellar cartilage lesion. PROMs using the Western Ontario and MacMaster Universities Osteoarthritis index, the Knee Society Score (Knee Society Function Score and Knee Society Knee Score), and the Hospital for Special Surgery score were evaluated preoperatively and at postoperative 2, 4, 6, and 8 years. The correlations between PROMs and the grade and location of the cartilage lesion were assessed. Additionally, radiologic outcomes including the patellar tilt angle and patellar height were assessed and their correlation with the grade of cartilage lesion was analyzed. Analysis of variance was used to determine statistical significance.

Results: There was no significant difference between PROMs according to the grades and locations of cartilage lesions at any postoperative follow-up. Radiologic parameters also showed no significant differences according to the grades of patellar cartilage lesions.

Conclusions: The grade and location of the patellar cartilage lesion had no influence on clinical outcomes in mobile-bearing TKA with patellar retention at short- and long-term follow-up.

Keywords: *Total knee arthroplasty, Patella, Articular cartilage*

Total knee arthroplasty (TKA) is a widely established treatment option for knee osteoarthritis. Over the past several decades, surgical techniques of TKA have made significant progress. However, whether or not to resurface the patella still remains controversial in TKA.[1-3)]

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Generally, patellofemoral pressure increases after TKA, which may subsequently lead to anterior knee pain. On the other hand, anterior knee pain might decrease after TKA owing to procedures such as patellar osteophyte removal and ligament balancing. Moreover, it is well accepted that denervation of the patella with electrocautery can reduce anterior knee pain after TKA even without patellar resurfacing.[4)]

Some authors advocate patellar resurfacing in that patients feel less pain and perform better in activities such as climbing stairs.[5,6)] On the other hand, others argue that there are no advantages in pain or function after patellar resurfacing. Previous studies have reported that there was

no difference in the revision rate between patellar resurfacing and non-resurfacing groups.[7,8] In addition, complications such as component wearing, patellar fracture, ligament rupture, patellofemoral malalignment, and anterior knee pain may possibly occur due to patellar resurfacing. Schiavone Panni et al.[9] reported that the overall complication rate of patellar resurfacing was 7%. As described above, there are many different, conflicting opinions on patellar resurfacing in TKA.

According to various studies, patellar resurfacing may be decided based on several intraoperative factors.[5,10-12] Patellar retention is usually recommended when the cartilage status is not poor and the thickness of the patella is relatively thin. Keblish et al.[13] suggested that there are some strong indications for patellar resurfacing: (1) large and thick patella, (2) deformed and non-conforming patella, (3) severe preoperative anterior knee pain, (4) multiple previous operations, and (5) poor patient compliance.

Poorer cartilage status may be closely related to anterior knee pain. However, little is known about the relationship between the cartilage status and the degree of anterior knee pain of the non-resurfaced patella in TKA. To the best of our knowledge, to date, no previous studies have focused on the relationship between the cartilage status of patella and the clinical outcomes of TKA.

The purpose of this study was to compare the patient-reported outcome measures (PROMs) according to the grade and location of the patellar cartilage lesion. Radiological outcomes were also compared. The authors hypothesized that the grade and location of the patellar cartilage lesion may be associated with the clinical outcome of TKA.

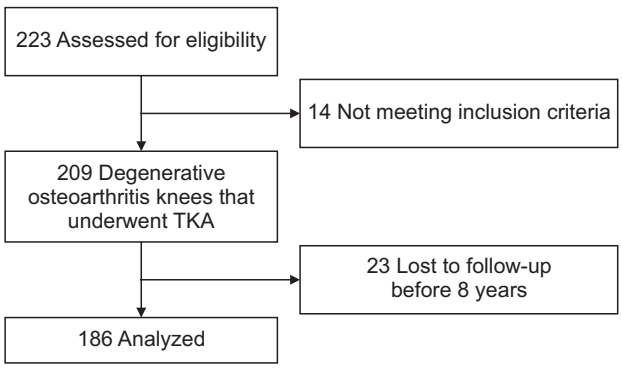

Fig. 1. Flowchart of patient selection in this study. TKA: total knee arthroplasty.

METHODS

Study Participants

This prospective study was approved by the Institutional Review Board of Seoul National University Hospital (No. H-1104-065-358), and written informed consent was obtained from all participants. A total of 165 patients with

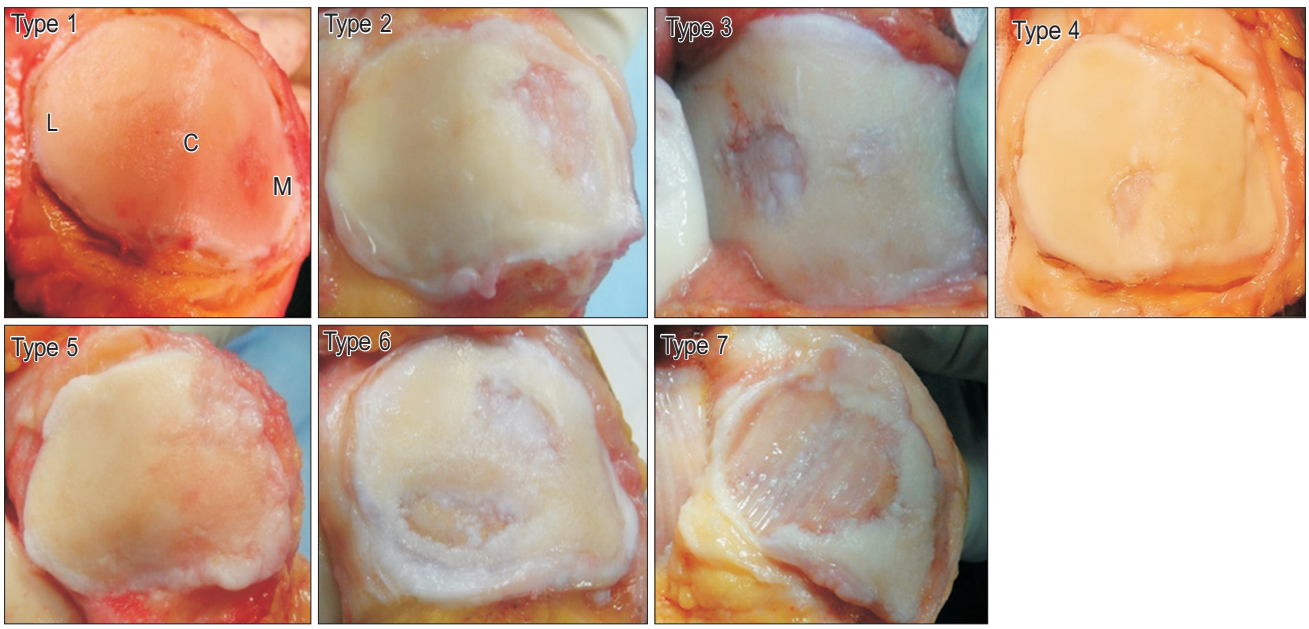

Fig. 2. Classification of the location of patellar cartilage lesions: type 1, no or minimal lesion; type 2, medial facet without central ridge; type 3, lateral facet without central ridge; type 4, central ridge only; type 5, medial facet with central ridge; type 6, lateral facet with central ridge; type 7, global lesions. L: lateral facet, C: central ridge, M: medial facet.

degenerative knee osteoarthritis (186 knees) undergoing primary TKAs were enrolled from November 2008 to May 2011. All of the knees were operated using the same instrument: cemented Low Contact Stress (LCS; DePuy Orthopaedics, Warsaw, IN, USA) mobile-bearing system. The patella was preserved in all surgeries. Patients with systemic inflammatory disease such as rheumatoid arthritis and those with a history of knee joint infection were excluded (Fig. 1). Out of 165 patients, 12 patients were men and the average age and body mass index were 67.7 ± 7.7 years and 26.5 ± 3.4 kg/m^2, respectively.

Surgical Technique

The TKAs were performed by a single, senior surgeon with more than 20 years of arthroplasty experience (MCL) using the same technique. After an anterior midline incision, a standard medial parapatellar arthrotomy was performed. Fat pad was minimally resected for joint exposure and guide insertion. An intramedullary guide was used for the femoral resection, while an extramedullary guide was used for the tibial resection. The posterior cruciate ligaments were retained, and mobile-bearing inserts were implanted in all patients. After an anteroposterior (AP) cut was completed using a femoral cutting block guide, the flexion gap was measured. If the flexion gap was larger than the extension gap, the femoral block was set 2 mm posterior to its initial position. The medial and lateral flexion gap differences were accepted if < 2 mm when measured using a laminar spreader. All prostheses were fixed with cement and the patella was managed by removal of osteophytes, peripheral electrocauterization for denervation, and additional contouring in cases with significant deformity. Before these procedures, patella thickness was measured using a surgical vernier caliper, and gross photographs of the patellar cartilage were taken intraoperatively to evaluate the severity and location of cartilage lesions. The same digital camera was used to take all the photographs by the same surgeon (MCL).

Patellar Cartilage Status Evaluation

The patellar cartilage was evaluated by the grade and location of the lesions. Cartilage lesion grade was determined using the International Cartilage Repair Society (ICRS) grading system. When there were more than 2 lesions, the grade of the more severe lesion was selected.

To describe the location of the patellar cartilage lesion, the authors quoted a previous paper[14] published by our group. The classifications are as follows: type 1, no or minimal lesion; type 2, medial facet without central ridge; type 3, lateral facet without central ridge; type 4, central ridge only; type 5, medial facet with central ridge; type 6, lateral facet with central ridge; and type 7, global lesions (Fig. 2).

Table 1. The ICRS Grade of the Study Patients

ICRS grade	No. of knees
0	4
1	30
2	42
3	51
4	59
Total	186

ICRS: International Cartilage Repair Society.

Table 2. The Location of the Patellar Cartilage Lesion in the Study

Type	Definition	No. of cases
1	No or minimal lesion	4
2	Medial facet without central ridge	22
3	Lateral facet without central ridge	29
4	Central ridge only	12
5	Medial facet with central ridge	33
6	Lateral facet with central ridge	42
7	Global lesion	44

Table 3. Two Different Classifications of Cartilage Lesion Location and the Number of Patients in the Study

Variable	No. of cases
Classifcation 1	
Location	
Medial (2, 5)	55
Lateral (3, 6)	71
Global (7)	44
Classification 2	
Location	
Localized (2, 3)	51
Diffuse (4, 5, 6, 7)	131

The number in parentheses denotes the location type of a patellar cartilage lesion according to Table 2.

Table 4. Clinical Variables According to the Grade of Patellar Cartilage Lesion in Each Postoperative Time Period

Variable	2 yr						4 yr						6 yr						8 yr					
	Gr0	Gr1	Gr2	Gr3	Gr4	*p*-value	Gr0	Gr1	Gr2	Gr3	Gr4	*p*-value	Gr0	Gr1	Gr2	Gr3	Gr4	*p*-value	Gr0	Gr1	Gr2	Gr3	Gr4	*p*-value
ROM score	122	123	122	121	122	0.983	123	120	124	120	123	0.875	127	123	125	120	124	0.981	125	121	122	123	121	0.745
HSS score	93	91.5	92.3	91.2	91.3	0.293	92	92.6	91.1	91.8	93.2	0.930	96.5	88.9	88.7	90.3	91.7	0.464	92.5	89.6	94.6	93.8	88.5	0.426
KSS	193	184	186	185	183	0.509	191	180	174	178	182	0.673	199	184	189	188	184	0.257	198	187	188	190	185	0.882
KSKS	98.8	96.1	97	97.4	96.3	0.358	96.3	96.8	92.0	96.6	96.2	0.505	99	93.6	89.8	92.2	92.9	0.477	98.5	95.5	95.1	96	93.6	0.438
KSFS	94	87.3	89.4	88	87.1	0.803	94.3	83.2	82.1	81.7	85.4	0.555	100	90	99	95.8	91.1	0.297	99	91.2	92.3	93.5	91.3	0.623
WOMAC score																								
Total	13	13.9	12.2	12.9	14.5	0.518	22	8.9	13.9	11.9	9.39	0.287	9.5	6.1	6.7	7.9	8.4	0.822	7.5	2.5	1	4	7.71	0.283
Pain	0	0.47	0.21	0.49	0.49	0.307	2	0.5	1.1	0.76	0.57	0.405	0.5	0.57	0.67	0.32	0.84	0.879	0	0	0.25	0.5	0.29	0.490
Stiffness	0.5	0.5	1.1	0.82	0.95	0.127	1	0.5	1	1.4	1.10	0.235	1	0.43	0.67	1.74	1.24	0.153	2	1	0.25	0.25	1.14	0.182
Function	12.5	12.9	11.0	11.6	13.3	0.278	19	7.9	11.8	9.79	7.71	0.273	8	5.07	5.33	5.84	6.32	0.900	5.5	1.5	0.5	3.25	6.29	0.337
Pain at going up or down stairs	0	0.07	0.17	0.16	0.08	0.659	0.5	0.25	0.21	0.17	0.14	0.651	0.5	0.14	0.33	0.05	0.28	0.290	0	0	0	0	0.14	0.736
Difficulty with ascending stairs	0.5	1.1	0.69	0.84	0.93	0.094	1	1	0.86	0.83	0.64	0.496	1	0.57	0.44	0.63	0.64	0.811	1	0.25	0.25	0.75	0.43	0.597
Difficulty with descending stairs	1.75	1.4	1.05	1.43	1.46	0.136	2	1.06	1.07	1.21	1.04	0.428	1	0.64	0.78	0.68	0.92	0.760	1	0.25	0.25	0.5	0.43	0.859
Difficulty with rising from sitting	0.25	0.7	0.36	0.45	0.54	0.670	1.5	0.63	0.79	0.72	0.43	0.205	0	0.29	0.44	0.26	0.2	0.617	0	0	0	0	0.29	0.736

Gr: grade, ROM: range of motion, HSS: Hospital for Special Surgery, KSS: Knee Society score, KSKS: Knee Society knee score, KSFS: Knee Society function score, WOMAC: Western Ontario and McMaster Universities.

Clinical and Radiologic Evaluations

For clinical evaluation, PROMs including Hospital for Special Surgery score, Knee Society score (Knee Society score: Knee Society knee score and Knee Society function score), and Western Ontario and McMaster Universities (WOMAC) score were obtained. The clinical scores were measured by an independent observer blinded to the study (JYC). The following 4 elements that represent anterior knee pain and related-function in WOMAC questionnaire were separately analyzed: (1) pain when going up or down stairs, (2) difficulty ascending stairs, (3) difficulty descending stairs, and (4) difficulty rising from sitting. Additionally, the range of motion (ROM) of the knee was also assessed. All clinical evaluations were performed preoperatively and biannually thereafter. Correlations between the cartilage lesion grade and the clinical parameters were analyzed.

Furthermore, to figure out the relationship between the location of the patellar cartilage lesion and the clinical variables, 2 methods were used. First, medial, lateral, and global lesions were compared (types 2, 5 vs. types 3, 6 vs. type 7, respectively). Next, localized and diffuse lesions were compared (types 2, 3 vs. types 4, 5, 6, 7, respectively). Correlations between the cartilage lesion location and the clinical parameters were analyzed.

Radiologic evaluations were performed to figure out whether the patellar tilt or height was related to the grade of a patellar cartilage lesion. For radiologic evaluations, the patellar tilt angle and patellar height (Insall-Salvati ratio and Blackburne-Peel index) were measured at postoperative 2 years. The patellar tilt angle and patellar height were each measured on the axial and lateral plain radiographs. All radiologic variables were measured by 2 observers blind to the study (DHR and HSH). The intra-class correlation coefficient was 0.92. Radiologic measurements were compared according to the ICRS grade.

Statistical Analysis

Student *t*-test or Mann-Whitney test was used in comparing the 2 groups, while analysis of variance or Kruskal-Wallis test was used to compare 3 or more groups in analyzing the clinical and radiologic parameters. The statistical significance was set at $p < 0.05$. Post hoc test was performed using Bonferroni, Tukey, Duncan, and Dunnett's T3 methods.

All statistical analyses were performed using IBM SPSS software ver. 25.0.0 (IBM Corp., Armonk, NY, USA).

Table 5. Average Patellar Tilt and Hieght According to the ICRS Grade of Patellar Cartilage Lesion in the Study

ICRS grade	Patellar tilt	Patellar height	
		Insall-Salvati ratio	Blackburne-Peel index
0	1.21	1.02	0.47
1	0.98	1.09	0.42
2	1.15	0.96	0.48
3	0.94	1.06	0.46
4	1.06	0.99	0.44
p-value	0.470	0.675	0.481

ICRS: International Cartilage Repair Society.

RESULTS

The mean (standard deviation) patella thickness was 21.1 mm (2.0 mm). The grades and locations of the cartilage lesions of the studied patients are presented in Tables 1-3. There was no significant difference between the clinical scores according to the grade of cartilage lesion preoperatively and at any postoperative follow-up (Table 4). Likewise, there was no significant difference between postoperative radiologic parameters according to the ICRS grade of the patella (Table 5).

Subgroup analyses were performed to evaluate the effect of the cartilage lesion location on PROMs. According to the above-mentioned 2 methods for classifying the cartilage lesion locations (Table 3), there was no significant difference between PROMs according to the location of the cartilage lesion at the short- and long-term follow-up (Tables 6 and 7),

DISCUSSION

This study is a long-term follow-up study of PROMs and radiological outcomes in patellar retention patients in TKA. The object of this study was to identify if there were any significant differences between the PROMs regarding the severity and location of the patellar cartilage lesions, and in short, no significant differences were observed.

As above-mentioned in the introduction, there have been many studies comparing the clinical outcomes of patellar resurfacing and retention in TKA, and conflicting results have been reported. According to certain previous studies,[7,8,10] non-resurfacing of the patella in TKA can lead to good clinical results as in our study, whereas non-

Table 6. Clinical Variables According to the Location (Medial, Lateral and Global) of Patellar Cartilage Lesion in Each Postoperative Time Period

Variable	2 yr				4 yr				6 yr				8 yr			
	Medial	Lateral	Global	*p*-value	Medial	Lateral	Global	*p*-value	Medial	Lateral	Global	*p*-value	Medial	Lateral	Global	*p*-value
ROM score	121	122	121	0.945	119	122	120	0.868	122	120	121	0.912	121	121	122	0.573
HSS score	91.8	91.8	91.8	0.708	92.3	92.3	92.2	0.216	90.5	90.5	90.7	0.565	91.3	96.7	90.3	0.901
KSS	185	185	185	0.935	179	179	178	0.165	185	186	186	0.710	187	187	190	0.977
KSKS	96.8	96.7	96.7	0.698	95.5	95.6	95.3	0.282	92.1	92.2	92.5	0.644	94.3	95.1	91.2	0.859
KSFS	88.0	87.8	88.2	0.817	83.1	83.1	83.4	0.254	92.5	93.3	93.3	0.694	92.3	92.1	89.1	0.752
WOMAC score																
Total	13.4	13.4	13.4	0.544	10.9	10.8	11.2	0.838	7.5	7.6	7.8	0.850	4.4	5.7	4.9	0.799
Pain	0.38	0.38	0.39	0.305	0.70	0.45	0.71	0.299	0.61	0.43	0.61	0.777	0.26	0.12	0.33	0.440
Stiffness	0.87	0.86	0.93	0.734	1.07	1.14	1.16	0.763	1.13	1.20	1.27	0.931	0.74	0.94	0.67	0.317
Function	12.2	12.2	12.2	0.517	9.1	9.2	9.3	0.822	5.8	5.9	5.9	0.837	3.4	4.6	3.9	0.808
Pain at going up or down stairs	0.12	0.12	0.12	0.930	0.18	0.11	0.16	0.091	0.19	0.26	0.20	0.585	0.05	0.14	0.07	0.177
Difficulty with ascending stairs	0.87	0.88	0.85	0.096	0.80	1.14	0.77	0.057	0.60	0.55	0.80	0.400	0.42	0.52	0.47	0.147
Difficulty with descending stairs	1.33	1.34	1.35	0.267	1.10	0.88	0.6	0.125	0.78	0.49	0.61	0.554	0.37	0.44	0.4	0.558
Difficulty with rising from sitting	0.5	0.51	0.47	0.588	0.62	0.63	0.61	0.730	0.27	0.35	0.27	0.411	0.11	0.36	0.13	0.177

ROM: range of motion, HSS: Hospital for Special Surgery, KSS: Knee Society score, KSKS: Knee Society knee score, KSFS: Knee Society function score, WOMAC: Western Ontario and McMaster Universities.

Table 7. Clinical Variables According to the Location (Localized and Diffuse) of Patellar Cartilage Lesion in Each Postoperative Time Period

Variable	2 yr			4 yr			6 yr			8 yr		
	Localized	Diffuse	*p*-value	Localized	Diffuse	*p*-value	Localized	Diffuse	*p*-value	Localized	Diffuse	*p*-value
ROM score	122	121	0.354	124	122	0.217	122	120	0.331	121	121	0.749
HSS score	91.7	91.8	0.486	93.4	91.8	0.259	90.6	90.1	0.406	91.9	91.0	0.665
KSS	183.1	185.2	0.156	180.3	178.2	0.227	179.3	184.4	0.116	188.5	186.4	0.231
KSKS	96.6	96.8	0.407	96.7	95.1	0.264	96.1	91.3	0.172	95.5	92.3	0.332
KSFS	86.4	88.5	0.158	83.6	83.1	0.831	93.6	93.1	0.758	93.0	94.1	0.685
WOMAC score												
Total	13.2	13.6	0.640	10.4	11.1	0.623	7.7	7.4	0.647	3.6	4.7	0.906
Pain	0.33	0.41	0.390	0.48	0.79	0.241	0.64	0.60	0.810	0.20	0.29	0.512
Stiffness	0.96	0.83	0.872	0.84	1.16	0.138	1.18	1.11	0.822	0.60	0.79	0.823
Function	11.9	12.3	0.616	9.1	9.1	0.686	5.9	5.7	0.572	2.8	3.6	0.898
Pain at going up or down stairs	0.12	0.12	0.932	0.16	0.19	0.637	0.23	0.18	0.415	0	0.07	0.221
Difficulty with ascending stairs	0.76	0.92	0.151	0.88	0.77	0.275	0.68	0.56	0.471	0.40	0.43	0.618
Difficulty with descending stairs	1.12	1.44	0.086	1.20	1.06	0.248	0.86	0.73	0.559	0.20	0.43	0.149
Difficulty with rising from sitting	0.47	0.51	0.379	0.72	0.58	0.861	0.23	0.29	0.654	0	0.14	0.221

ROM: range of motion, HSS: Hospital for Special Surgery, KSS: Knee Society score, KSKS: Knee Society knee score, KSFS: Knee Society function score, WOMAC: Western Ontario and McMaster Universities.

resurfacing of the patella may cause anterior knee pain and poorer functional outcome.[5,6] But to our knowledge, there has been no long-term study on the relationship between the characteristics of the patellar lesions and PROMs in patella-retained TKAs. We investigated not only the grade but also the location of patellar lesions and neither of them affected the PROMs. The results of our study suggest that maybe the patellar cartilage lesion itself is not the cause of anterior knee pain after TKA.

Meanwhile, the prosthesis design has been regarded as a core etiologic factor causing anterior knee pain after TKA.[15] Although problems of the patellar clunk syndrome have been mostly resolved with the evolution of posterior-stabilized TKA designs, rotating platform (RP) designs are known to be susceptible to patellar clunk syndrome.[16] Painful patellar clunk occurred in 9.7% of the patients with Press-Fit Condylar Sigma RP/rotating platform-flex knee system (PFC RP/RPF), while the incidence was low with the PS type of the same instrument. Similarly, high rates of patellar clunk syndrome have been also reported by other authors: 11 of 71 PFC RPF TKAs (16.7%) and 15 of 113 PFC RP TKAs (13.3%).[17,18] Several studies have claimed that prosthesis designs are associated with increased patellofemoral joint problems. For example, femoral box designs with a sharp transition into the intercondylar notch and proximally positioned or wide femoral box designs are associated with patellofemoral joint problems including patellar clunk syndrome and anterior knee pain.[19-22] Fukunaga et al.[18] suggested that the larger intercondylar box ratio (ratio between the length of the intercondylar box and the AP dimension of the femoral component) might be one of the reasons for the higher incidence of patellar clunk syndrome. The design of LCS system we used in this study was relatively anatomical on the skyline view of the plain radiograph (Fig. 3). The intercondylar portion of the femoral component and the non-resurfaced patella were

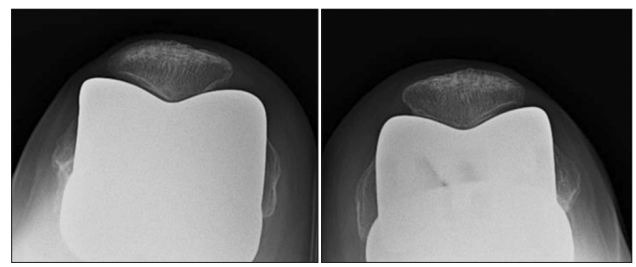

Fig. 3. Skyline radiographs of a patient who underwent total knee arthroplasty using the Low Contact Stress system with patellar preservation. Note that the patella sits congruently on the femoral sulcus of the implant.

maintained with great congruency. Maybe this could have caused less patellofemoral contact stress and eventually led to prevention of anterior knee pain. There was no case of revision surgery due to patellofemoral joint problems including anterior knee pain in all 186 knees of this study.

It is not to say that patellar resurfacing is unnecessary in all TKAs. Previously, many studies reported that resurfacing of the patella resulted in less anterior knee pain and better functional outcomes.[5,6,10] But the authors carefully hypothesized that for certain instruments like LCS system that we used, patellar retention was not inferior to patellar resurfacing if the designs of patellofemoral components were similar to the native anatomy. Of course, tentative managements of the patella including osteophyte removal, peripheral electrocauterization for denervation, and contouring were needed in all cases.

There were several limitations of the study. First, in this study, there was a lack of a scoring system that specifically represents anterior knee pain, such as the Kujala anterior knee pain scale. Instead, the authors used 4 items of the WOMAC score questionnaire that may reflect the patellofemoral symptoms. Moreover, results cannot be directly applied to all TKA instruments because the study was performed using a single instrument system. In addition, there was no comparison between the patellar resurfacing group and the retention group. Nevertheless, long-term clinical outcomes of patellar retention in TKA could be obtained.

In conclusion, the grade and location of the cartilage lesions of the patella did not affect the clinical outcomes of the non-resurfaced patellae in mobile-bearing TKAs.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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