



# Comparison of Clinical Outcomes after Total Knee Arthroplasty with and without Patellar Resurfacing in the Same Patients

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**Background:** Patellar resurfacing is performed in total knee arthroplasty (TKA) to improve pain in the anterior compartment of the knee joint and to restore proper coordination and movement of the patellofemoral joint. The purpose of this study was to analyze differences in clinical outcomes according to patellar resurfacing in patients who underwent bilateral TKA.

**Methods:** Forty-three patients who underwent bilateral primary TKA with patellar resurfacing on one side only were included. Patellar resurfacing was performed selectively according to the status of the patella cartilage surface. Knee Society score (knee and function), Feller score, Kujala score, and Samsung Medical Center (SMC) score (pain and function) were evaluated.

**Results:** There were no significant differences in Knee Society pain and function scores, Feller score, Kujala score, and SMC pain and function scores according to patellar resurfacing. On the comparison of SMC scores, there was no difference except for two questions.

**Conclusions:** It is advisable not to perform resurfacing on normal patellae. However, in order to apply this result to damaged patellae, comparative studies between resurfaced patellae and damaged patellae are needed.

**Keywords:** *Patellofemoral joint, Patellofemoral arthrosis, Patellar resurfacing*

Anterior knee pain and patellofemoral dysfunction are common complications of total knee arthroplasty (TKA).<sup>1,2)</sup> In TKA, patellar resurfacing is performed to improve pain in the anterior compartment of the knee joint and to restore proper coordination and movement of the patellofemoral joint. However, there is a lack of consensus regarding the necessity for patellar resurfacing, which is an important issue in the area of knee arthroplasty. Previous prospective randomized clinical trials and meta-analyses

reported no significant difference in clinical and functional outcomes between patellar resurfacing and nonresurfacing groups.<sup>3-9)</sup> However, some studies have reported that patellar resurfacing can decrease the reoperation risk and postoperative anterior knee pain.<sup>6,10-12)</sup>

There are three surgical patellar management protocols in TKA: resurfacing, no resurfacing, and selective resurfacing. Practices vary among surgeons based on education, tradition, experience, and clinical evidence.<sup>13)</sup> Most studies examined nonselective patellar resurfacing without consideration of the intraoperative status of the patellar articular cartilage.<sup>3,4,7,8)</sup> In such cases, it would be unreasonable to compare the resurfaced patella with diseased cartilage or healthy cartilage, and more accurate comparison methods are required. Definitive conclusions regarding the need for patellar resurfacing are challenging because of heterogeneity in prosthetic designs, indications, individual characteristics, outcome measurements, and

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follow-up duration.<sup>14-16)</sup>

Therefore, we designed this study to allow more specific comparisons by minimizing confounding factors and comparing outcomes. We conducted the study using the Feller, Kujala, and Samsung Medical Center (SMC) scores focused on the patellofemoral joint evaluation. In patients who underwent TKA in both knees, one side with patellar resurfacing and the other side without resurfacing (when the patellofemoral joint was relatively normal), the outcomes of both sides were compared. We hypothesized that there would be no difference in clinical outcomes between the resurfaced and unresurfaced sides in patients who underwent bilateral TKA with selective patellar resurfacing.

## METHODS

This study was ethically approved by the Institutional Review Board of Hanyang University Medical Center (IRB No. HYUH 2019-12-033). Patient consent was waived because the waiver of consent did not adversely affect the rights or welfare of the patients, and the risk to the patients was extremely low.

The records of a total of 43 patients who underwent bilateral primary TKA with unilateral patellar resurfacing from February 2004 to November 2018 were retrospectively reviewed. Patients with degenerative osteoarthritis (OA) or rheumatoid arthritis (RA) with at least 1 year of follow-up were included. Patients who underwent other operations such as fracture repair or osteotomy, those with greater than 5 years between the first and second operations, and patients with other factors that could affect function or pain in the lower extremities such as spinal disease, soft-tissue disease, and neuromuscular disease were excluded from the analysis.

All operations were performed by the same surgeon (CHC) using the standard medial parapatellar approach and all prostheses were the posterior-stabilized type. Six different implants were used: NexGen (Zimmer Biomet, Warsaw, IN, USA), Scorpio (Stryker, Mahwah, NJ, USA), Vanguard (Biomet, Warsaw, IN, USA), Sigma PFC (DePuy Orthopedics, Warsaw, IN, USA), ATTUNE knee system (DePuy Orthopedics, Warsaw, IN, USA), and Genesis II (Smith and Nephew, Memphis, TN, USA). All patients underwent surgery using the same implant on both sides. The designs of all femoral components used in surgery were patella-friendly (asymmetrical, anatomic femoral groove with elevated lateral trochlear flange and distal extension of the trochlear groove). In the process of patellar resurfacing, osteophytes around the patella were excised in

all patients. The position and size of the patellar component were determined by making the highest point of the component as close as possible to the median ridge of the patella. When replication of the original median ridge was difficult due to the shape of the patella, the medial side of the patellar component was attached to the medial border of the patella. As a result, there were cases where the highest point of the patellar component was lateralized than the original median ridge of the patella.

Although preoperative Merchant view plain films were used to evaluate the patella in all patients, the procedure for the management of the patella was determined in the operating room. Patellar resurfacing was performed selectively based on the intraoperative evaluation of the patellar cartilage surface. If any part of the chondral surface of the patella was Outerbridge grade 2 or higher, it was judged that resistance would increase causing pain during patellofemoral contact, so resurfacing was performed.

Patients were followed up at 4 weeks, 6 months, 1 year, 2 years, 5 years, and 10 years postoperatively. Clinical outcomes were evaluated using the Knee Society score (knee and function), Feller score, Kujala score, and SMC score (pain and function). We analyzed differences in each question of the SMC score according to the follow-up duration. For postoperative radiographic evaluation, routine standing anteroposterior, lateral with 30-degree flexion of the knee joint, and Merchant view radiographs were obtained. The Insall-Salvati ratio was calculated using lateral radiographs and patellar tilt was measured using Merchant view radiographs. Implant failure, loosening, and polyethylene wear were evaluated with standing anteroposterior radiographs and Merchant view radiographs. The increase in periprosthetic radiolucency, focal radiolucency of 2 mm or more, and component migration were defined as loosening. Obvious joint space narrowing compared to previous radiographs was considered to indicate polyethylene wear.

Statistical analysis was performed using IBM SPSS ver. 24.0 (IBM Corp., Armonk, NY, USA). A  $p < 0.05$  was considered statistically significant. For evaluation of normality of data, Kolmogorov-Smirnov test and Shapiro-wilk test were used. Independent  $t$ -tests were used for comparison of means for normally distributed continuous variables, and the Mann-Whitney  $U$ -test was used for variables that did not follow a normal distribution. For comparisons of paired data, the paired  $t$ -test was used for normally distributed variables, and the Wilcoxon signed-rank test was used for variables that did not follow a normal distribution.

## RESULTS

There were 31 patients with OA and 12 patients with RA. Forty-two patients were female and 1 patient was male. The mean age at surgery was 64.42 years (range, 38–78 years) for the resurfacing group and 64.35 years (range, 38–78 years) for the nonresurfacing group ( $p = 0.599$ ). All patients were followed for a minimum of 1 year postoperatively, with an average follow-up of 5.68 years (range, 1–14 years) in the resurfacing group and 5.92 years (range, 1–14 years) in the nonresurfacing group ( $p = 0.160$ ). The mean interval between the first surgery and the second surgery was 5.20 months (range, 0–49 months). The mean body mass index (BMI) was 26.66 kg/m<sup>2</sup> (range, 18.66–39.60 kg/m<sup>2</sup>) in the resurfacing group and 26.67 kg/m<sup>2</sup> in the nonresurfacing group (range, 18.66–39.35 kg/m<sup>2</sup>) ( $p = 0.814$ ). No intraoperative complications or postoperative revision procedures due to patellar component-related complications were identified.

The preoperative and postoperative Knee Society knee score and function score of the resurfaced side and

nonresurfaced side were significantly different. The postoperative Knee Society scores (knee and function), SMC scores (pain and function), Feller score, and Kujala score were not statistically significantly different between the resurfaced side and the unresurfaced side (Tables 1 and 2).

The follow-up periods were subgrouped into less than 5 years and 5 years or more. When comparing the outcomes according to the postoperative follow-up period, there was no difference in clinical results between the resurfacing group and the nonresurfacing group (Table 3). There was also no significant difference in clinical results between the follow-up of less than 5 years and the follow-up 5 years or more in both the resurfacing group and the nonresurfacing group (Table 4).

The clinical outcomes of OA and RA patients were separately evaluated. The difference in clinical outcomes between the resurfacing and nonresurfacing groups was not statistically significant in both OA and RA groups (Table 5). The comparison between the OA and RA groups showed no statistically significant difference in clinical results (Table 6).

**Table 1.** Knee Society Scores of TKA Patients with or without Patellar Resurfacing

Variable	Resurfacing group (n = 40)	Nonresurfacing group (n = 40)	p-value
Knee Society knee score			
Preoperative	33.63 (0–70)	31.18 (0–70)	0.180
Postoperative	86.73 (44–100)	86.20 (49–100)	0.572
p-value	< 0.001	< 0.001	
Knee Society function score			
Preoperative	56.00 (10–80)	54.88 (35–80)	0.618
Postoperative	77.25 (45–100)	78.25 (45–100)	0.103
p-value	< 0.001	< 0.001	

Values are presented as mean (range).  
TKA: total knee arthroplasty.

**Table 2.** Outcomes of Clinical Scores Related to Patellofemoral Joint

Variable	Resurfacing group (n = 40)	Nonresurfacing group (n = 40)	p-value
Feller score	25.60 (14–30)	25.42 (13–30)	0.708
Kujala score	66.84 (44–97)	66.14 (39–97)	0.268
SMC pain score	29.58 (0–70)	29.81 (0–70)	0.808
SMC function score	32.44 (0–62.5)	32.27 (0–62.5)	0.864

Values are presented as mean (range).  
SMC: Samsung Medical Center.

**Table 3.** Clinical Outcomes of TKA Patients with or without Patellar Resurfacing by Follow-up Period

Variable	Resurfaced side	Nonresurfaced side	p-value
Less than 5 years	(n = 20)	(n = 20)	
Follow-up (yr)	1.7 (1–4)	1.6 (1–4)	
Knee Society knee score	88.50 (60–100)	87.85 (64–100)	0.916
Knee Society function score	74.25 (50–100)	75.75 (50–100)	0.180
Feller score	24.65 (16–30)	24.70 (17–30)	0.952
Kujala score	68.05 (45–97)	67.40 (45–97)	0.544
SMC pain score	27.55 (2–58)	27.10 (2–59)	0.494
SMC function score	30.86 (0–62.5)	31.50 (7.5–62.5)	0.635
5 Years or more	(n = 23)	(n = 23)	
Follow-up (yr)	9.04 (5–14)	9.57 (6–14)	
Knee Society knee score	86.04 (44–100)	85.48 (49–100)	0.812
Knee Society function score	81.52 (45–100)	81.96 (45–100)	0.317
Feller score	27.00 (14–30)	26.70 (13–30)	0.553
Kujala score	68.91 (44–91)	67.48 (40–91)	0.479
SMC pain score	31.78 (0–70)	32.17 (0–70)	0.929
SMC function score	33.59 (0–62.5)	33.72 (0–62.5)	0.474

Values are presented as mean (range).

TKA: total knee arthroplasty, SMC: Samsung Medical Center.

On the analysis of SMC questions, the scores for the questions pertaining to “sitting down on a chair” and “sitting on a chair for 10 minutes” were significantly higher on the resurfaced side ( $p = 0.032$ ,  $p = 0.027$ ). The other questions of the SMC score did not show statistically significant difference (Fig. 1). The outcomes of the OA group showed the same pattern as those of the RA group and there was no significant difference between the two groups when compared according to the follow-up period of less than 5 years and 5 years or more.

The mean preoperative patellar tilt angle was 4.81 (range, -3.10 to 14.00) in the resurfacing group and 5.07 (range, -1.70 to 13.00) in the nonresurfacing group ( $p = 0.662$ ). The mean postoperative patellar tilt was 2.75 (range, -7.10 to 18.00) in the resurfacing group and 4.61 (range, -2.94 to 15.00) in the nonresurfacing group ( $p < 0.001$ ). The preoperative Insall-Salvati ratio was 1.12 (range, 0.75–1.73) in the resurfacing group and 1.11 (range, 0.83–1.56) in the nonresurfacing group ( $p = 0.719$ ). The mean postoperative Insall-Salvati ratio was 1.13 (range, 0.80–2.23) in the resurfacing group and 1.10 (range, 0.82–1.64) in the nonresurfacing group ( $p = 0.406$ ). The postoperative

patellar tilt angle in the resurfacing group was significantly lower than the preoperative measure ( $p = 0.014$ ).

## DISCUSSION

The extent to which a patient feels pain or discomfort and the degree of expression may vary from patient to patient. Thus, it is important to consider individual differences in pain sensitivity in clinical evaluation. A full understanding of individual differences in pain is challenging. Mechanisms contributing to individual differences could be psychophysical, sociological, neural, genetic, or others.<sup>17</sup> Comorbidities and other patient characteristics can affect outcomes. One method that can be used to control for individual differences is comparing outcomes in the same group, such as comparing both extremities (resurfacing on one side and no resurfacing on the other side) in the same patient.

Kajino et al.<sup>18</sup> reported that patellar resurfacing is recommended to prevent pain in the patellofemoral joint and erosive changes of the patellar articular surface based on comparison of the results of the group who

**Table 4.** Comparison of Clinical Outcomes between Patients Followed up for Less Than 5 Years and Those Followed up for 5 Years or More

Variable	Less than 5 years (n = 20)	5 Years or more (n = 23)	p-value
Knee Society knee score			
RE	88.50 (60–100)	86.04 (44–100)	0.628
NON	87.85 (64–100)	85.48 (49–100)	0.662
Knee Society function score			
RE	74.25 (50–100)	81.52 (45–100)	0.163
NON	75.75 (50–100)	81.96 (45–100)	0.268
Feller score			
RE	24.65 (16–30)	27.00 (14–30)	0.077
NON	24.70 (17–30)	26.70 (13–30)	0.085
Kujala score			
RE	68.05 (45–97)	68.91 (44–91)	0.783
NON	67.40 (45–97)	67.48 (40–91))	0.676
SMC pain score			
RE	27.55 (2–58)	31.78 (0–70)	0.461
NON	27.10 (2–59)	32.17 (0–70)	0.416
SMC function score			
RE	30.86 (0–62.5)	33.59 (0–62.5)	0.594
NON	31.50 (7.5–62.5)	33.72 (0–62.5)	0.783

Values are presented as mean (range).

RE: resurfaced side, NON: nonresurfaced side, SMC: Samsung Medical Center.

underwent resurfacing and the other group who did not undergo resurfacing during TKA in RA patients after an average of 6.6 years. Choi et al.<sup>19)</sup> reported that the effect of reducing anterior knee pain with patellar nonresurfacing TKA gradually decreased at 2 and 7 years of follow-up in OA patients. In the current study, in order to consider the change of the patellofemoral joint, which can occur in both RA and OA according to the mid-term follow-up period, the comparison was made between those with a follow-up of less than 5 years and those with 5 years or more. And in consideration of the possibility of erosion of patellar cartilage, the RA patient group was analyzed separately. There was no difference in the results according to the postoperative period and arthritis type. Although not statistically significant, the SMC function score showed worse results in patients with 5 years or more of follow-up and RA, but the Knee Society function score showed better results. It can be considered that the direction of changes in the entire knee joint and patellofemoral joint

may be different depending on the passage of time and the type of arthritis. Because the Knee Society score (pain and function) evaluates the entire condition of the knee, it is problematic to evaluate the patellofemoral joint with the Knee Society score. To evaluate the tibiofemoral joint and patellofemoral joint together, it is recommended using the evaluation system focused on the patellofemoral joint such as Feller, Kujala, and SMC scores together with the Knee Society score.

The results of this study showed no significant difference in clinical scores between the patellar resurfacing group and the nonresurfacing group. Previous studies have likewise shown no significant difference in anterior knee pain evaluated by Feller, Kujala, or SMC scores in patients who underwent patellar resurfacing compared to those who did not.<sup>3-5,7-9)</sup> However, one would expect some kind of difference in sound or position. Waikakul et al.<sup>20)</sup> studied the effect of patellar resurfacing in TKA on position, and patients without patellar resurfacing had better

**Table 5.** Clinical Outcomes of TKA Patients with or without Patellar Resurfacing (OA vs. RA)

Variable	Resurfaced side	Nonresurfaced side	p-value
OA	(n = 31)	(n = 31)	
Follow-up (yr)	5.29 (1–14)	5.54 (1–14)	0.244
Knee Society knee score	89.77 (44–100)	88.10 (49–100)	0.213
Knee Society function score	76.61 (45–100)	77.58 (45–100)	0.184
Feller score	26.03 (14–30)	26.06 (13–30)	0.939
Kujala score	68.16 (44–97)	67.61 (39–97)	0.318
SMC pain score	27.16 (0–70)	27.51 (0–70)	0.765
SMC function score	30.24 (0–62.5)	30.16 (0–62.5)	0.952
RA	(n = 12)	(n = 12)	
Follow-up (yr)	6.67 (1–12)	6.83 (1–12)	0.317
Knee Society knee score	80.50 (50–100)	82.67 (50–100)	0.176
Knee Society function score	82.08 (45–100)	82.92 (45–100)	0.317
Feller score	25.58 (16–30)	25.00 (20–30)	0.692
Kujala score	69.42 (47–95)	68.92 (48–87)	0.776
SMC pain score	36.67 (2–59)	35.75 (2–59)	0.599
SMC function score	37.71 (0–60)	37.29 (7.5–62.5)	0.740

Values are presented as mean (range).

TKA: total knee arthroplasty, OA: osteoarthritis, RA: rheumatoid arthritis, SMC: Samsung Medical Center.

results. Therefore, new methods for evaluating the status of artificial patellofemoral joints are needed.

On the comparison of preoperative and postoperative radiologic outcomes such as the Insall-Salvati ratio and patellar tilt angle, there was no difference except for postoperative patellar tilt angle of the resurfaced patella compared with the same side before surgery and opposite side after surgery. These outcomes could be surgical changes. Lee et al.<sup>21)</sup> reported the patellar tilt angle decreased after surgery in both cases where the location of the patella component was the same as that of the preoperative median ridge and when it was centralized. And they reported a more centralized patellar component position showed a smaller patellar tilt angle and a better ability to rise from a chair. In the current study, the noresurfacing group showed bigger patellar tilt angle and better outcome in the functional status of “sitting down on chair” and “10 minutes sitting in a chair.” Since there are many factors that affect the patellar tilt angle, such as the position of the patella component, the design of femoral component, and the rotation of implants, further research is needed on the relationship between the change of patellar tilt angle and

functional level after patellar resurfacing.

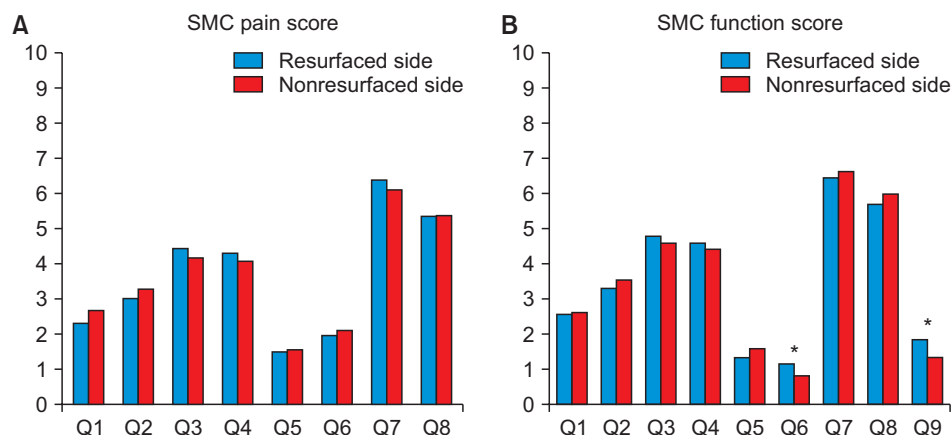
One of the main functions of the patella is that the cartilage minimizes resistance to the femoral trochlear, thereby minimizing the reduction of extension force. With damaged cartilage, friction between the femoral trochlear and subchondral bone surface may increase, which may reduce the extensor mechanism efficiency or cause pain. In this study, we did not compare the unresurfaced pathologic patella with the resurfaced patella. We can infer from these results that patellar resurfacing can produce outcomes similar to those of a normal patella. In other words, resurfacing is not necessary for normal patellae, and resurfacing may be helpful for arthritic patellae because intact cartilage acts similar to a polyethylene-metal surface. Care should be taken to determine whether the preoperative status of the patellar cartilage affects interpretation of the outcomes. Burnett et al.<sup>9)</sup> reported that the intra-articular cartilage status was not a predictor of outcome by performing nonselective patellar resurfacing in a randomized controlled trial in 90 patients. In order to clearly determine whether resurfacing is necessary or not in a damaged patella, further comparative research between resurfaced

**Table 6.** Comparison of Clinical Outcomes between Patients with OA and RA

Variable	OA (n = 31)	RA (n = 12)	p-value
Knee Society knee score			
RE	89.77 (44–100)	80.50 (50–100)	0.051
NON	88.10 (49–100)	82.67 (50–100)	0.530
Knee Society function score			
RE	76.61 (45–100)	82.08 (45–100)	0.369
NON	77.58 (45–100)	82.92 (45–100)	0.369
Feller score			
RE	26.03 (14–30)	25.58 (16–30)	0.947
NON	26.06 (13–30)	25.00 (20–30)	0.265
Kujala score			
RE	68.16 (44–97)	69.42 (47–95)	0.781
NON	67.61 (39–97)	68.92 (48–87)	0.779
SMC pain score			
RE	27.16 (0–70)	36.67 (2–59)	0.151
NON	27.51 (0–70)	35.75 (2–59)	0.277
SMC function score			
RE	30.78 (0–62.5)	37.71 (0–60)	0.233
NON	30.16 (0–62.5)	37.29 (7.5–62.5)	0.238

Values are presented as mean (range).

OA: osteoarthritis, RA: rheumatoid arthritis, RE: resurfaced side, NON: nonresurfaced side, SMC: Samsung Medical Center.



**Fig. 1.** Samsung Medical Center (SMC) pain (A) and function (B) scores of total knee arthroplasty (TKA) patients with or without patellar resurfacing. SMC pain score: Q1, climbing upstairs; Q2, walking down stairs; Q3, rising from floor; Q4, sitting down on floor; Q5, rising from a chair; Q6, rising from squatting position; Q7, squatting; Q8, sitting on a chair for 10 minutes. SMC function score: Q1, climbing upstairs; Q2, walking down stairs; Q3, rising from floor; Q4, sitting down on floor; Q5, rising from a chair; Q6, sitting down on a chair; Q7, rising from squatting position; Q8, squatting; Q9, sitting on a chair for 10 minutes. \*Significantly different value.

patellae and damaged patellae is needed.

This study has some limitations. The study sample size was small. This is because we included patients who underwent TKA on both sides with selective resurfacing only on one side. This study also included both OA and RA patients, who may have different outcomes due to differences in disease pathophysiology. However, comparisons of outcomes in this study were conducted in the same patients, thereby overcoming this particular limitation. And the comparison between the OA and RA groups did not show any difference in clinical results.

In this retrospective case-control study, there was no statistically significant difference in Knee Society score or other clinical outcomes measures of the anterior knee compartment (Feller, Kujala, and SMC score), including almost all sub-items of the SMC score, between the nearly normal and resurfaced patellae in the same patient. Because the data showed similar outcomes in the normal pa-

tellae and resurfaced patellae, it is advisable not to perform resurfacing on normal patellae. However, in order to apply this result to damaged patellae, more comparative studies between resurfaced patellae and damaged patellae are needed.

## CONFLICT OF INTEREST

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

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