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Original Article

Long-term Results of Primary Total Knee Arthroplasty with and without Patellar Resurfacing

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Among patients that underwent total knee arthroplasty from June, 1990 to January, 1999, 61 cases (44 patients) that could be followed for more than 10 years were included in this study. The patients were divided into a patellar retention group and a patellar resurfacing group, and were compared with regard to their clinical and radiological outcomes. In patients undergoing primary TKA, a selective patellar resurfacing protocol was used. The indications for patellar retention were a small patella, nearly normal articular cartilage, minimal preoperative patellofemoral pain, poor patellar bone quality, and young patient age. When patellar retention was performed, osteophytes of the patella were removed and marginal electrocauterization was carried out. There were 25 cases (20 patients) in the patellar retention group and 36 cases (29 patients) in the patellar resurfacing group. The mean follow-up period was 140.7 months in the patellar retention group and 149.0 months in the patellar resurfacing group. The selective patellar resurfacing with total knee arthroplasty had a favorable outcome; there were a significant difference noted between the 2 groups in the functional scores, which showed better outcomes in the patellar resurfacing group than in the patellar retention group.

Key words: total knee arthroplasty (TKA), selective patellar resurfacing, patellar retention, patellar resurfacing

The question of whether to resurface the patella in patients undergoing primary total knee arthroplasty has been studied extensively, but remains controversial. During the early stages of total knee arthroplasty (TKA), replacement of only the tibiofemoral joint is common. After this procedure, symptoms related to the patellofemoral joint are reported in approximately 40 to 58% [1–4] of patients. These findings have contributed to the development of patellar resurfacing, which is now widely used. Surgeons performing total knee replacement using various methods now frequently add the patellar component [5–6]. As a result, there have been many patellofemoral complications reported such as loosening of the patellar component with wear, patellar fractures, patellar tendon rupture, patellofemoral misalignment and patellar clunk syndrome [7]. Therefore, patellar retention and resurfacing continues to be debated for patients undergoing TKA. Some surgeons are proponents of routine patellar resurfacing; the clinical studies on patients after patellar resurfacing have shown better outcomes with less residual anterior

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knee pain [8–10] and improved knee scores [11–12]. Other investigators advocate patellar retention [13–15], and still others recommend selective patellar resurfacing [16–18]. Currently, the selective patellar resurfacing option is widely accepted; however, in practice, the surgeon's preference seems to dictate whether or not the patella is resurfaced.

We previously reported the mid-term results of a retrospective, clinical study of selective patellar resurfacing in patients undergoing primary TKA [19]. Here, the clinical and radiological results after more than 10 years of follow-up after TKA are reported.

Materials and Methods

Of the 71 cases (53 patients) that underwent TKA from June, 1990 to January, 1999 at our institution, 61 cases (44 patients) that could be followed for more than 10 years were included in the study. Six cases (retention, 5 cases; resurfacing, 1 case) were lost to follow up. Four cases (retention, 3; resurfacing, 1) died of unrelated causes. The clinical follow-up rate for the patellar retention group and patellar resurfacing group were 75% and 94%, respectively. All operations were performed by the same surgeon at the same hospital. All enrolled patients had the diagnosis of degenerative osteoarthritis and fell under grade 4 of the Kellgren-Lawrence classification. The patients were divided into the patellar retention group and the patellar resurfacing group, and their clinical and radiological results were compared. Patellar management was conducted according to the guidelines for TKA. The indications for patellar retention were a small patella (less than a 22-mm anterior-posterior thickness found intraoperatively), nearly normal articular cartilage, minimal preoperative patellofemoral pain, poor patellar bone quality, and young patient age (<60 years). In these cases, patelloplasty, removal of osteophytes in the patella and marginal electrocauterization, were performed. If there was a patellar subluxation or inadequate patellar tilt in either group, a lateral retinacular release was performed for correction.

There were 25 cases (20 patients) in the patellar retention group and 36 cases (29 patients) in the patellar resurfacing group. At the time of operation, the average age was 63.6 years (55 to 77) in the patellar retention group and 64.7 years (52 to 75) in the patellar resurfacing group. In the patellar resurfacing group, a cemented polyethylene patellar component was used in 34 cases and a metal back patella component was used in 2 cases. Calipers were used to measure the patellar thickness intra-operatively, and the preoperative and postoperative patellar thickness measurements were equal. The operation was performed through a standard medial parapatellar approach in all cases. The mean follow-up period was 140.7 months (range, 122 to 168 months) in the patellar retention group and 149.0 months (range, 121 to 216 months) in the patellar resurfacing group. There were 57 female cases (retention, 24; resurfacing, 33) and 4 male cases (retention, 1; resurfacing, 3); while the patellar component was fixed with cement, all patients received cementless femoral and tibial components of TKA, featuring an anatomically designed deep femoral groove, the so-called patellar-friendly design (LCS, DePuy, Warsaw, IN, USA). Among them, 26 cases received the meniscal type of polyethylene bearing (retention group, 15; resurfacing, 11) and 35 cases received the cruciate-sacrificing type of polyethylene bearing (retention, 10; resurfacing, 25).

The patients were evaluated using the knee rating system of the American Knee Society (knee score and functional score), the knee arthroplasty rating system of the Hospital for Special Surgery (HSS score), the Bristol patellar score, and the Lonner Patellofemoral score. The knee rating system of the American Knee Society and the HSS score are commonly used for evaluation of osteoarthritis of the knee joint; however, these scoring systems do not include symptoms and assessment of the patellofemoral joint. For this reason, a more recently developed specialized assessment index was used for the patellofemoral joint. The Bristol patellar score includes parameters easily used including a physical examination, and the Lonner Patellofemoral score can be used for a more detailed evaluation; both were used in this study.

Radiological evaluation was performed at every clinic visit including preoperatively and at the follow-up more than 10 years after the operation. The radiographs included a standing anteroposterior view, lateral view and Merchant view. The x-rays were assessed using the radiographic evaluation system of the Knee Society [20]. The Keblish method [21] was

used to evaluate patellofemoral congruence [22–23]; this method of measuring lateral or medial patellar displacement after TKA has been valuable in assessing individual films and serial or comparative skyline views (Fig. 1). The Mann-Whitney U-test was used for the analysis with the significance level set at a p-value < 0.05.

Results

Clinical results. There was no significant difference between the 2 groups preoperatively with regard to the knee score, the HSS score and the range of motion (Table 1). At the last follow-up visit, the knee scores and functional scores of patients in the patellar retention group were 95.0 and 60.0, and in the patellar resurfacing group they were 93.5 and 77.5 (Table 2). There was a significant difference between the 2 groups with regard to the functional score and the walking score, one of the three subscores of the functional score (the other two are the stairs and the deduction subscores). The walking subscore in the patellar retention group was 45.0 and in the patellar resurfacing group 30.0. In each group, the functional score was more strongly correlated with the walking than the stairs subscore (Table 3).

The HSS scores for the patellar retention and patellar resurfacing groups were 83.0 and 87.0, respectively. Although the mean HSS score was slightly higher in the patellar resurfacing group, the difference was not statistically significant. The Bristol patellar score and the Lonner Patellofemoral score for the patellar retention group were 9.0 and 82.0, and for the patellar resurfacing group 9.0 and 82.0; there was no significant difference between the 2 groups (Table 2). There were no patients with anterior knee pain in the patellar retention group. One patient in the patellar resurfacing group had vague knee pain at night, but this patient had no limitation of movement during daily activities.

Radiographic analysis. The mean preoperative anatomical axis (tibiofemoral angle) in the varus position averaged 6.2° for the patellar retention group and 5.1° for the patellar resurfacing group, with no significant difference (Table 4). There was no significant difference between the 2 groups based on the Knee Society's radiological evaluation system using the postoperative standard X-rays at the final follow-up period (Table 5). Alignment of the femoral and tibial

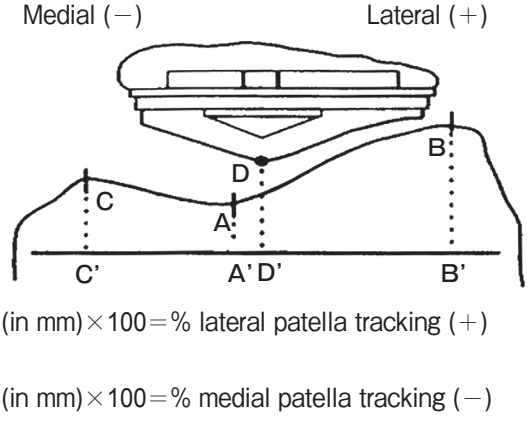

Fig. 1 The method of measuring patellofemoral congruence. **A**, Midline of the femoral groove; **B**, **C**, Highest portion on the lateral and medial condyles; **D**, Lowest portion of the patella. **A'**, **B'**, **C'**, and **D'**: **A**, **B**, **C**, and **D** dropped to the horizontal line.

Table 1 Preoperative clinical data

		Group 1	Group 2
Knee score	Mean (± S.D.)	53.7 (± 15.9)	50.5 (± 16.2)
	P-value	0.522	
Functional score	Mean (± S.D.)	46.3 (± 15.3)	39.8 (± 17.5)
	P-value	0.205	
HSS score	Mean (± S.D.)	65.3 (± 10.4)	61.1 (± 11.3)
	P-value	0.219	
Range of motion	Mean (± S.D.)	125.0 (± 19.4)	116.5 (± 18.0)
	P-value	0.154	

Group 1, patellar retention group; Group 2, patellar resurfacing group.

Table 2 Postoperative clinical data

		Group 1	Group 2
Age	Median (IQR)	62.0 (59.0– 68.0)	64.0 (61.0–70.0)
	P-value	0.358	
Knee score	Median (IQR)	95.0 (84.5–100.0)	93.5 (79.25–100.0)
	P-value	0.299	
Functional score	Median (IQR)	60.0 (45.0– 70.0)	77.5 (55.0–80.0)
	P-value	*0.044	
Walking	Median (IQR)	30.0 (20.0– 40.0)	45.0 (30.0–50.0)
	P-value	*0.048	
Stairs	Median(IQR)	30.0 (30.0– 30.0)	30.0 (30.0–30.0)
	P-value	0.381	
Deduction	Median (IQR)	0.00 (0.00– 0.00)	0.00 (0.00–0.00)
	P-value	0.590	
HSS score	Median (IQR)	83.0 (80.0– 87.5)	87.0 (79.75–91.25)
	P-value	0.188	
Bristol patellar score	Median (IQR)	9.0 (8.0– 10.0)	9.0 (8.0–10.0)
	P-value	0.978	
Lonner patellofemoral score	Median (IQR)	82.0 (78.0– 85.0)	82.0 (77.0–91.0)
	P-value	0.775	
Range of motion	Median (IQR)	130.0 (122.5–140.0)	128.0 (120.5–138.0)
	P-value	0.456	

Group 1, patellar retention group; Group 2, patellar resurfacing group.

components was not statistically different between the 2 groups. The mean postoperative anatomical axis averaged 4.8° in the valgus position for the patellar retention group and 4.5° for the patellar resurfacing group, with no significant difference (Table 4). For the evaluation of patellofemoral congruence, 2 clinicians reviewed the immediate postoperative and final follow-up x-rays independently. The immediate postoperative x-rays showed that the average congruence was 96.3% in all cases; for the patellar retention group 96.4% and 81% of the patients had 100% congruent tracking, for the patellar resurfacing group 96.3% and 84% of the patients had 100% congruent tracking. In the final follow-up x-rays, the average congruence was 93.1% in all cases; for the patellar retention group 94.2% and 80% of the patients had 100% congruent tracking, and for the patellar resurfacing group 91.6% and 82% of the patients had 100% congruent tracking. There were no significant differences between the 2 groups (p-value > 0.05).

Complications. Seven cases required revision: Three in the patellar retention group and 4 in the patellar resurfacing group. Six revisions were due to wear of the polyethylene bearing and one was due to an avulsion fracture of the posterior cruciate ligament at the tibial attachment side, which was managed by pull-out suturing with a change of the polyethylene bearing. Thus, in all 7 cases, the polyethylene bearing was changed. With revision defined as the end point, the likelihoods of survival of the prosthesis of the patellar retention group (Group 1) and patellar resurfacing group (Group 2) were 96.8% and 91.7%, respectively, for 10 years, by Kaplan-Meier analysis (p-value = 0.363). None of the patients has required further revision surgery for patellofemoral problems. One case in the patellar resurfacing group had an open reduction and internal fixation due to a periprosthetic fracture of the distal femur.

Discussion

Patellofemoral problems are one of the most common complications encountered after primary TKA. The early designs for total knee prostheses did not

Table 3 Correlation coefficient within the functional score

Group				Func-S	Walking	Stairs	Deduction
Spearman's rho	Resurfacing	Func-S	Correlation Coefficient	1.000	0.915**	0.653**	−0.376*
			Sig. (2-tailed)	.	0.000	0.002	0.031
			N	36	36	36	36
		Walking	Correlation Coefficient	0.915**	1.000	0.318	−0.605**
			Sig. (2-tailed)	0.000	.	0.171	0.005
			N	36	36	36	36
		Stairs	Correlation Coefficient	0.653**	0.318	1.000	−0.287
			Sig. (2-tailed)	0.002	0.171	.	0.220
			N	36	36	36	36
		Deduction	Correlation Coefficient	−0.376*	−0.605**	−0.287	1.000
			Sig. (2-tailed)	0.031	0.005	0.220	.
			N	36	36	36	36
	Retention	Func-S	Correlation Coefficient	1.000	0.981**	0.780**	−0.367*
			Sig. (2-tailed)	.	0.000	0.000	0.039
			N	25	25	25	25
		Walking	Correlation Coefficient	0.981**	1.000	0.762**	−0.382
			Sig. (2-tailed)	0.000	.	0.000	0.106
			N	25	25	25	25
		Stairs	Correlation Coefficient	0.780**	0.762**	1.000	−0.080
			Sig. (2-tailed)	0.000	0.000	.	0.744
			N	25	25	25	25
		Deduction	Correlation Coefficient	−0.367*	−0.382	−0.080	1.000
			Sig. (2-tailed)	0.039	0.106	0.744	.
			N	25	25	25	25

*Correlation is significant at the 0.05 level (2-tailed), **Correlation is significant at the 0.01 level (2-tailed).

include a patellar resurfacing component and were reported to be associated with a 40 to 58% rate of patellofemoral or anterior knee pain. The high rate of postoperative anterior knee pain contributed to concerns about patellofemoral resurfacing after the first patellar replacement in 1974. Since then, there has been a gradual increase in the concern about patellar resurfacing.

Previously, early symptoms associated with the patellofemoral joint were treated by methods that included patellectomy or a soft-tissue realignment procedure [1, 24]. In 1975, the 'dome' patella was developed at the Hospital for Special Surgery primarily to treat patellofemoral arthritis and severe chondromalacia patellae [25]. Dome resurfacing decreased patellar-related complications by 10% to 25% [25–27]. These findings led to the recommendation that patellar resurfacing should become standard practice for patients undergoing TKA. The frequency of patellar resurfacing increased during the mid 1980s.

Table 4 Preoperative and postoperative anatomical axis

Anatomical axis		Group 1	Group 2
Preoperative	Median	Varus 6.2°	Varus 5.1°
	(IQR)	(Varus 3.5°–Varus 7.9°)	(Valgus 0.2°–Varus 7.5°)
	P-value	0.279	
Postoperative	Median	Valgus 4.8°	Valgus 4.5°
	(IQR)	(Valgus 2.5–Valgus 5.9)	(Valgus 3.1–Valgus 6.9)
	P-value	0.426	

Group 1, patellar retention group; Group 2, patellar resurfacing group.

Table 5 Postoperative radiological evaluation by the Knee Society's radiological evaluation system

Angle	Group 1	Group 2
Alpha angle	95.8 ± 7.3	96.2 ± 8.1
Beta angle	88.3 ± 7.5	88.2 ± 7.1
Omega angle	6.2 ± 1.5	6.6 ± 1.4
Gamma angle	3.5 ± 1.0	3.8 ± 0.7
Sigma angle	84.9 ± 5.0	84.6 ± 6.5

Group 1, patellar retention group; Group 2, patellar resurfacing group.

However, the numerous problems reported with patellar-resurfaced TKA, such as loosening of the patellar component with wear, patellar fractures, patellar tendon rupture, patellofemoral misalignment and the patellar clunk syndrome, has rekindled interest in patellar retention [22, 28, 29].

After TKA, the articular surface of the patella must adapt to the geometry of the femoral component; this process is called 'remodeling'. Remodeling has been referred to as stress contouring and is a biological response producing gradual adaptation of the articular surface to the trochlea and the condyles of the femoral component [21, 30]. This gradual process is minimized if the surface is exposed to an anatomically designed femoral component with a constant curve and uniform femoral geometry. By contrast, non-anatomical designs require excessive remodeling. Excessive patellar stress may lead to abnormal remodeling with poorer outcomes, which are more likely to occur with non-anatomical femoral flanges. For this reason, Epinette *et al.* proposed the use of patella-friendly components to reduce point loading and improve tracking [31]. We used an LCS prosthesis with an anatomical femoral design and patelloplasty in all patellar-retention cases, which served to promote remodeling and decrease postoperative anterior knee pain.

In deciding whether or not to perform patellar resurfacing during TKA, we followed the indication of Levitsky *et al.*, [10] who recommended patellar retention in cases of a small patella, well-preserved patellofemoral articular cartilage noted intraoperatively, minimal preoperative patellar pain, poor patellar bone quality and younger patient age (< 60 years).

Several randomized clinical studies [8, 15] have reported a high frequency of anterior knee pain in both the patellar retention group and the resurfacing group. For example, Waters *et al.* [8] reported anterior knee pain prevalences of 25.1% in the non-resurfacing group and 5.3% in the resurfacing group.

Burnett *et al.* [31] reported that overall, surgeons performing TKA without resurfacing the patella can expect a 10% prevalence of anterior knee pain, which may require subsequent patellar resurfacing. They also suggested that it should not always be presumed that anterior knee pain before and after total knee arthroplasty is secondary to a patellofemoral etiology. However, when the various reports [10, 12, 16, 21, 27, 29, 32] are examined more closely, it appears that there may be little or no difference between resurfaced and nonresurfaced knees in terms of overall function and knee pain. Therefore, routine resurfacing for all patients without acceptable indications is not reasonable, because the complications related with the patellar resurfacing, as well as the operation time, can be reduced with patellar retention. In our study there was no significant anterior knee pain. Both groups have shown good outcomes. Similar to our paper, Epinette and Manley [33] reported low rates of anterior knee pain in a case series of selective patellar resurfacing. These results might have been due to the strict indications used for patellar retention

as well as the use of a prosthesis with an anatomical femoral design. For the patellar retention group in the present study, mild pain was attributed to the procedure of patelloplasty, which was associated with minimal preoperative patellar pain. We found no significant differences between the 2 groups except for the functional scores, which were better in the patellar resurfacing group. However, in a prior study reported by this group on midterm results [19], the functional scores showed no significant differences. The results of the present study demonstrate that patellar resurfacing with TKA showed superior outcomes according to the functional scores than patellar retention over the long term. There was significant difference between the resurfaced and nonresurfaced group with regard to the functional score, particularly the walking score, which was strongly correlated with the functional score. The difference in the walking score led to the difference in the overall functional score. Several studies [3, 13] have demonstrated that patients with a nonresurfaced patella have inferior stair-climbing activity. In contrast, our study found no significant difference in stair-climbing ability but rather in walking, which demands lower patellofemoral contact force.

The limitations of this study include the following. First, this study has a retrospective study design. In addition, the number of patients in each group was limited. Moreover, the results of the present study may be specific for the type of prosthesis used, the surgeon, or the institution at which the patients were treated.

Conclusions. After a minimum follow-up of 10 years, there were no differences in clinical and radiological results, except for the functional score, in 61 TKA knees in which patellar resurfacing was and was not undergone, according to a selective protocol. In the final follow-up, the functional scores in the patellar resurfacing group showed better results than in the patellar retention group. On the basis of our results, we concluded that selective resurfacing of the patella with careful consideration of procedural indications and the use of a prosthesis that has a femoral components designed with a more anatomic patellofemoral groove were associated with an overall successful patient outcome.

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