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Primary Knee

A Prospective, Single-Center, Randomized Controlled Study Comparing Non-Resurfacing versus Resurfacing in a Cohort of 250 Posterior-Stabilized Total Knee Arthroplasty With a Minimum Five-Year Follow-Up

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ABSTRACT

Background: Despite extensive research, patellar management during total knee arthroplasty (TKA) remains controversial. We therefore asked the following: Is there a difference in clinical and radiological outcomes at a minimum 5-year follow-up with a modern posterior-stabilized TKA performed with or without patellar resurfacing (PR)?

Materials and methods: This single-center prospective randomized trial included 250 knees (245 patients) undergoing primary TKA between April 2017 and November 2018. Exclusion criteria were isolated patellofemoral osteoarthritis, constrained TKA, and preoperative flexion less than 90°. Patients were randomized into PR or patellar nonresurfacing (PNR) groups, receiving the same posterior-stabilized "patella-friendly" prosthesis. Clinical evaluation at 5-year follow-up included the Knee Society Score (KSS), Forgotten Joint Score, Kujala and Lille scores for anterior knee pain, and range of motion. Radiographic assessment evaluated patellofemoral osteoarthritis progression and patellar implant loosening. Complications and surgical revisions were recorded.

Results: There were 213 knees (109 in PR, 104 in PNR) available with a 5-year follow-up (9% lost to follow-up and 4% deceased). Clinical outcomes showed no significant differences between groups (KSS knee: $P = 0.10$; KSS function: $P = 0.19$; Forgotten Joint Score: $P = 0.24$; Kujala: $P = 0.36$; Lille: $P = 0.43$). There were five patients (4.5%) in PNR who required secondary PR, whereas two patients (1.8%) in PR required revision of the patellar button. The revision rate for patellofemoral causes was 3.8%, without significant difference between groups ($P = 0.16$). At 60 months, implant survival was similar between PR and PNR (93.6 and 91.8%; $P = 0.96$).

Conclusion: This large prospective randomized study found no clinical advantage of routine PR at 5-year follow-up. While resurfacing may reduce anterior knee pain, it also introduces risks such as fracture and maltracking. In the context of patella-friendly posterior-stabilized implants, these findings support a more selective approach, which should be guided by objective criteria.

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Persistent anterior knee pain (AKP) affects up to 30% of patients after total knee arthroplasty (TKA) and remains strongly associated with postoperative dissatisfaction [1–5]. This has led to ongoing debate about the necessity of patellar resurfacing (PR) to optimize clinical outcomes [6]. While resurfacing of the patella may reduce the risk of AKP, it is associated with complications, primarily component loosening and patellofemoral (PF) maltracking [7–9]. Conversely, omitting PR carries the risk of secondary resurfacing procedures due to AKP, which accounts for more than 50% of all TKA revisions [10,11].

To our knowledge, no clear approach has demonstrated superiority. Some surgeons suggest systematic resurfacing to prevent persistent or future AKP and reduce revision rates, while others prefer a selective or non-resurfacing strategy to minimize associated complications [12]. The development of new implant designs, particularly "patella-friendly" femoral components, has further influenced this discussion by improving PF tracking, potentially reducing the necessity for resurfacing [13–17].

Despite numerous studies and meta-analyses, findings remain inconsistent due to methodological differences, variations in implant designs, and the heterogeneity of patient populations [18–22]. Additionally, most research has focused on short- to mid-term outcomes, leaving long-term effects on function and implant survival less clearly defined.

The aim of this study was to compare the long-term clinical and radiological outcomes, as well as complication and revision rates, at a minimum 5-year follow-up in patients undergoing posterior-stabilized, patella-friendly TKA with or without PR. This study seeks to provide additional evidence to guide surgical decision-making in this context. We hypothesized that there would be no significant long-term differences between resurfacing and non-resurfacing in this setting.

Materials and Methods

Study Design and Setting

This prospective randomized study was conducted at a single institution between April 1, 2017, and November 30, 2018. This study was registered on ClinicalTrials.gov (NCT03081260) and received approval from the Clinical Research and Innovation Office on December 23, 2016, under reference number (2016-A01697-44). Additionally, it was approved by our hospital's Institutional Review Board as a Randomized Controlled Trial (69HCL16_645). All patients provided written informed consent, which included a detailed explanation of the study protocol and the potential risks associated with both surgical procedures.

Participants

A total of 245 consecutive patients (250 knees) were randomized to undergo either PR or patellar nonresurfacing (PNR). The inclusion criteria encompassed adults requiring primary TKA for medial femoro-tibial osteoarthritis (OA), with possible involvement of the lateral femoro-tibial or PF compartments, or those diagnosed with osteonecrosis of the femoral condyle or tibial plateau. Patients were excluded if they presented with isolated PF OA, required revision TKA, had coronal laxity necessitating a more constrained implant, or exhibited preoperative knee flexion of less than 90°.

Sample Size and Randomization

This initial study was designed with the intention of having a 10-point difference (and SD of 30 points) in the Knee Society Score (KSS) between the two groups as the endpoint of statistical measurement [23]. With an α of 0.05 and a power of 80%, 112 patients were required in each group. Randomization was performed using a computer-generated random sequence with variable block sizes of four and six to ensure balanced group allocation. The allocation sequence was managed through a secure electronic system, accessible only to study personnel not involved in the surgical procedures. On the day before surgery, an orthopaedic resident uninvolved in the operation accessed the system to assign the patient to one of the treatment groups. The study followed an open-label design.

Participant Flow

Initially, 125 knees were included in both the PR and PNR groups (Figure 1). At two years postoperatively, 123 knees remained available for analysis in each group. At five years postoperatively, there were 23 patients who were lost to follow-up, and there were 10 patients who passed away before reaching their 5-year follow-up, resulting in 104 knees in the PNR and 109 knees in the PR cohorts.

Descriptive Data

No differences of age, sex, body mass index, side, hip-knee-ankle axis, or any of the preoperative clinical parameters (including range of motion and KSS) were noted between the PNR and PR cohorts (Table 1).

Surgical Procedure

All procedures were carried out by two senior surgeons following a standardized surgical technique. The same prosthesis was implanted in all patients: a fixed-bearing posterior-stabilized TKA (Anatomic, AMPLITUDE, Valence, France). All components were cemented using high-viscosity cement. A medial parapatellar approach was systematically employed. The femoral components were aligned based on the posterior femoral condyles, implanted in neutral rotation, and anteriorized by one mm when necessary to prevent anterior notching. The appropriate size was determined using an anterior cortical reference. The femoral component was available in eight sizes [1–8], while the patellar component had four diameter options (30, 33, 36, and 39 mm) with a fixed thickness of eight mm. For PR, the bone was resected to maintain a minimum residual thickness of 12 mm, with a target of 13 to 15 mm depending on the preoperative measurement, which was verified using a caliper. A cemented onlay symmetric polyethylene button was implanted in all resurfaced patellae. The goal was to recreate the preoperative patellar thickness as closely as possible to maintain physiological PF biomechanics.

A lateral retinacular release was performed selectively to optimize patellar tracking in cases of patellar subluxation during knee flexion. Regardless of resurfacing status, a parapatellar synovectomy was conducted to reduce the risk of clunk syndrome. In nonresurfaced patellae, systematic cauterization was performed. No lateral facetectomy was carried out in this study.

Assessment

Each patient underwent a preoperative consultation with a senior surgeon, followed by a standardized postoperative follow-up for a minimum of five years. Functional and clinical assessments included the International KSS (for knee and function) [24], and range of motion was assessed both pre- and postoperatively. Additionally, two specific scores evaluating AKP were included: the Kujala score and

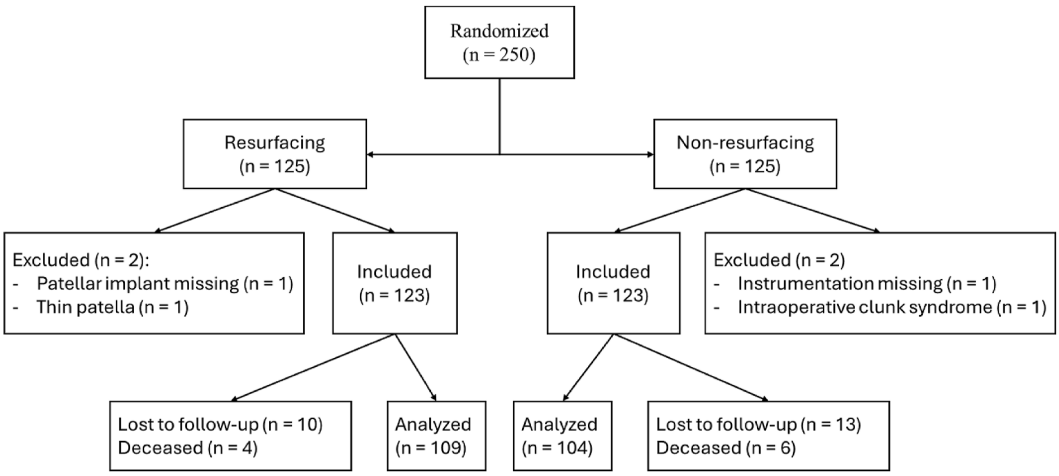

Figure 1. Consolidated Standards of Reporting Trials (CONSORT) flow diagram of the current study.

the Lille score were collected postoperatively, as well as the Forgotten Joint Score (FJS) [25–27]. All questionnaires were completed by the patients at the most recent 5-year follow-up.

Radiological evaluations comprised weight-bearing anteroposterior and lateral views, axial patellar views at 30° of flexion, and standing long-leg radiographs. The severity of PF OA was documented pre- and postoperatively using the Iwano classification [28]. All radiographic measurements were conducted by the same independent observer using the measurement tools provided by the radiological software (Centricity Universal Viewer, version 6.0 SP10.2, GE Healthcare, Illinois, USA). In addition, implant survival and reoperation rates for any cause were noted during follow-up. Revision events were defined using the same criteria in both groups: revision surgery, whether secondary resurfacing in the PNR group or patellar button revision in the PR group, was indicated only in cases of clinically relevant AKP. Radiographic changes alone, including PF OA progression or radiolucent lines, were not sufficient to justify revision.

Rehabilitation

All patients followed the same standardized postoperative rehabilitation protocol, irrespective of whether PR was performed. The program included immediate full weight-bearing as tolerated, range of motion exercises starting on postoperative day one, and progressive muscle strengthening focusing on quadriceps and hamstring activation. Supervised physiotherapy sessions were conducted two to three times per week during the first six weeks, followed by a home-based exercise program. Gait training and functional recovery exercises were introduced progressively, with the goal of achieving at least 90° of knee flexion within the first two weeks and near-complete functional range by six weeks postoperatively.

Data Analyses

All statistical analyses were performed using Statistical Package for Social Sciences (Version 27.0, IBM, New York, USA). Continuous variables were assessed for normality using Shapiro–Wilk tests and

Table 1
Demographic, Clinical, and Radiological Preoperative Data Comparing Patellar Nonresurfacing (PNR) With Patellar Resurfacing (PR).

Variables	Group PNR (n = 104)	Group PR (n = 109)	*P*-Value
Age [years]	77 (71 to 83)	75 (70 to 80)	0.17
Sex			0.68
Women	56 (58)	59 (64)	
Men	44 (46)	41 (45)	
Body mass index	29.6 (25.9 to 33.2)	29.0 (25.4 to 32.8)	0.88
Side			0.32
Right	53 (55)	60 (65)	
Left	47 (49)	40 (44)	
Follow-up [months]	68 (65 to 74)	68 (64 to 73)	0.80
Clinical data			
Extension [degrees]	0 (0 to 5)	0 (0 to 5)	0.44
Flexion [degrees]	130 (120 to 130)	130 (110 to 130)	0.10
KSS knee	61 (53 to 69)	60 (50 to 70)	0.98
KSS function	65 (50 to 70)	65 (50 to 75)	0.92
Radiographic data			
HKA [degrees]	172.6 (161 to 187)	173.0 (159 to 185)	0.60
mFA [degrees]	90.5 (84 to 97)	90.4 (84 to 96)	0.75
mTA [degrees]	85.3 (80 to 97)	86.1 (76 to 92)	0.033
Tibial slope [degrees]	5.6 (1 to 18)	5.8 (−2 to 15)	0.68
Patellar tilt [degrees]	4.1 (−5 to 15)	4.3 (−3 to 16)	0.73
Patellar translation [millimeters]	2.7 (−4 to 9)	2.6 (−3 to 15)	0.96

Data are presented as either median (quartile 1 to quartile 3), mean (minimum to maximum), or % (n) depending on the data and statistical test used.
KSS, Knee Society Score; HKA, hip-knee-ankle axis; mFA, medial femoral angle; mTA, medial tibial anglpe.

visual inspections of histograms. Parametric continuous variables were reported as means (and ranges) and compared using independent Student's *t*-tests. Nonparametric continuous variables were presented as medians with their interquartile ranges (IQRs, Q1 to Q3) and compared using the Mann–Whitney *U*-tests. Categorical variables were expressed as frequencies and percentages. Comparisons between categorical variables were performed using the *Chi*-square or Fisher's exact tests, as appropriate, based on expected cell counts. Survival analysis was conducted using the Kaplan–Meier method with censoring at the time of death, and differences between survival curves were assessed using the log-rank test. Statistical significance was set at a *P*-value lower than 0.05.

Results

Clinical and Radiological Results

At five years postoperatively, there were no significant differences between the PNR group and the PR group in terms of knee extension (PNR: 0 [IQR 0 to 0] versus PR: 0 [IQR 0 to 0]; $P = 0.59$) or flexion (PNR: 120 [IQR 120 to 130] versus PR: 130 [IQR 120 to 130]; $P = 0.10$; Table 2). Both groups achieved a median KSS knee of 100 (IQR 86 to 100) in the PNR group and 100 (IQR 90 to 100) in the PR group, with no significant difference ($P = 0.21$). Similarly, the KSS function was comparable: PNR (100 [IQR 80 to 100]) versus PR (100 [IQR 90 to 100]), with no significant difference ($P = 0.19$). The difference in KSS knee from preoperative to 5-year follow-up was on average 31 (range, −18 to 65) in the PNR group and 34 (range, −22 to 80) in the PR group ($P = 0.24$). The difference in KSS function was 30 (IQR 11 to 40) in the PNR group and 30 (IQR 20 to 40) in the PR group ($P = 0.45$). The Forgotten Joint Score was also similar between groups, with a median of 100 (IQR 80 to 100) for PNR and 100 (IQR 90 to 100) for PR ($P = 0.24$). The Kujala Score was 100 (IQR 82 to 100) in the PNR group and 100 (IQR 89 to 100) in the PR group ($P = 0.36$), while the Lille Score was 100 (IQR 85 to 100) for PNR and 100 (IQR 89 to 100) for PR ($P = 0.43$).

At two years postoperatively, PF OA in the PNR group was classified as stage 0 in 39 patients (35.1%), stage 1 in 44 patients (39.6%), stage 2 in 21 patients (18.9%), stage 3 in six patients (5.4%), and stage 4 in one patient (0.9%) By five years postoperatively, disease progression was observed, with a decrease in stage 0 cases to 10 patients (8%) and an increase in stage 1 (52 patients, 43%), stage 2 (24 patients, 20%), stage 3 (12 patients, 10%), and stage 4 (two patients, 2%).

Complications

Overall, no differences between the PNR and PR groups were seen regarding any of the complications (Table 3, and Figures 2 and 3). In total, five new complications occurred between 24 and 60 months of follow-up, with no statistical difference between the PNR cohort (PR, partial quadriceps tendon rupture, and revision TKA due to aseptic loosening) compared to the PR cohort (one revision TKA due to infection and one revision TKA with reason unknown).

Survival Analysis

The 5-year survival rate was 91.8% in the PNR cohort and 93.6% in the PR cohort ($P = 0.49$, Figure 4). Similarly, the 5-year rate of reoperations for any cause was similar between the PNR cohort and the PR cohort (85% for both cohorts), without any statistical difference according to the log-rank test ($P = 0.81$; Figure 5).

Discussion

The findings of this study indicate no significant differences in clinical or functional outcomes between the PNR and PR groups at five years postoperatively. Both groups demonstrated similar improvements in range of motion and patient-reported outcomes, including KSS knee, KSS function, Forgotten Joint Score, Kujala Score, and Lille Score. Notably, despite radiographic progression of PF OA in the PNR group, for which a total of five secondary PRs (out of the initial 125 knees) were performed, this did not translate into

Table 2
Postoperative Clinical and Radiological Preoperative Data Comparing Patellar Nonresurfacing (PNR) With Patellar Resurfacing (PR).

Variables	Group PNR (n = 104)	Group PR (n = 109)	*P*-Value
Clinical data at 5 years of follow-up			
Extension [degrees]	0 (0 to 0)	0 (0 to 0)	0.59
Flexion [degrees]	120 (120 to 130)	130 (120 to 130)	0.10
KSS knee	100 (86 to 100)	100 (90 to 100)	0.21
KSS function	100 (80 to 100)	100 (90 to 100)	0.19
Difference KSS knee	31 (−18 to 65)	34 (−22 to 80)	0.24
Difference KSS function	30 (11 to 40)	30 (20 to 40)	0.45
Forgotten Joint Score	100 (80 to 100)	100 (90 to 100)	0.24
Kujala Score	100 (82 to 100)	100 (89 to 100)	0.36
Lille Score	100 (85 to 100)	100 (89 to 100)	0.43
Radiographic data at 2 years of follow-up			
HKA [degrees]	177.6 (170 to 186)	177.8 (172 to 183)	0.63
mFA [degrees]	89.8 (84 to 94)	90.0 (82 to 95)	0.57
mTA [degrees]	88.8 (82 to 94)	88.5 (84 to 93)	0.45
Tibial slope [degrees]	1.7 (−3 to 6)	1.8 (−4 to 8)	0.79
Patellar tilt [degrees]	3.7 (−3 to 37)	5.2 (−8 to 75)	0.12
Patellar translation [mm]	2.3 (−4 to 16)	0.9 (−6 to 17)	<0.001
Radiographic data at 5 y of follow-up			
Patellofemoral OA	Stage 0: 10 (8) Stage 1: 52 (43) Stage 2: 24 (20) Stage 3: 12 (10) Stage 4: 2 (2)	NA	NA

Data are presented as either median (quartile 1 – quartile 3), mean (minimum to maximum), or % (n) depending on the data and statistical test used.
KSS, Knee Society Score; HKA, hip-knee-ankle axis; mFA, medial femoral angle; mTA, medial tibial angle; OA, osteoarthritis.

Table 3
Overview of the 5-Year Complications With a Comparison Between NPR (No Patellar Resurfacing) and PR (Patellar Resurfacing) Cohorts.

Variables	Group NPR (104)	Group PR (109)	*P*-Value
Complications necessitating surgery			
Revision for all causes	14 (15)	14 (15)	>0.99
Revision for patellofemoral causes	6 (6)	2 (2)	0.16
Patellar resurfacing	5 (5)	NA	NA
Patellar instability	1 (1)	0	0.49
Button change	0	2 (2)	0.50
Fracture	1 (1)	0	0.49
Aseptic loosening	1 (1)	1 (1)	>0.99
Infection	2 (2)	4 (4)	>0.99
Stiffness	MUA: 2 (2) Arthrolysis: 1 (1)	MUA: 3 (3) Arthrolysis: 3 (3)	0.54
Popliteus tendinopathy requiring tenotomy	0	1 (1)	>0.99
Quadriceps tendon rupture	1 (1)	0	0.49
Loose body removal	1 (1)	0	0.49
Unknown	0	1 (1)	>0.99
Complications not requiring surgery			
Partial quadriceps tendon rupture	1 (1)	0	0.49
Aseptic loosening	0	1 (1)	>0.99
Clunk syndrome	2 (2)	0	0.24
J-sign	1 (1)	0	0.49
Patellar fracture	0	1 (1)	>0.99
Patellar tendinopathy	1 (1)	1 (1)	>0.99

MUA, manipulation under anesthesia; NA, not available.

a measurable decline in patient-reported functional outcomes. Furthermore, complication rates and surgery-free survival were comparable between both cohorts, reinforcing the notion that PR may not confer a distinct advantage in the long-term follow-up of TKA patients.

This study has several potential limitations that should be acknowledged. While the follow-up period of five years is substantial, longer term studies may be required to assess potential late complications or functional decline. In addition, neither surgeons nor the patients were blinded to the study protocol. Patients were able to fill in the patient questionnaires on their own (except for the KSS knee), limiting any bias caused by the surgeon being present while doing so. This bias is inherent to surgical trials comparing procedural variations. Although most outcomes were self-reported by patients, the lack of blinding may have introduced a perception bias, particularly in subjective scores. Additionally, the number of patients lost to follow-up may have introduced selection bias and ultimately influenced the statistical power of the study. While patients were meticulously contacted in case they did not present at the 5-year follow-up, some selection bias may have arisen in the current study. However, the loss to follow-up rate in both treatment arms was similar, which might limit the extent of any selection bias. As well, the study does not account for any stratification based on preoperative AKP. Although randomization aimed to balance such factors, the absence of AKP-specific assessment may have limited our ability to explore its influence on outcomes. Finally, the study utilized a specific posterior-stabilized and "patella-friendly" implant design, and results may not be generalizable to all TKA designs.

At five years postoperatively, there were no significant differences between the PNR group and the PR group in terms of knee range of motion, KSS, FJS, Kujala, and Lille scores. Our findings are

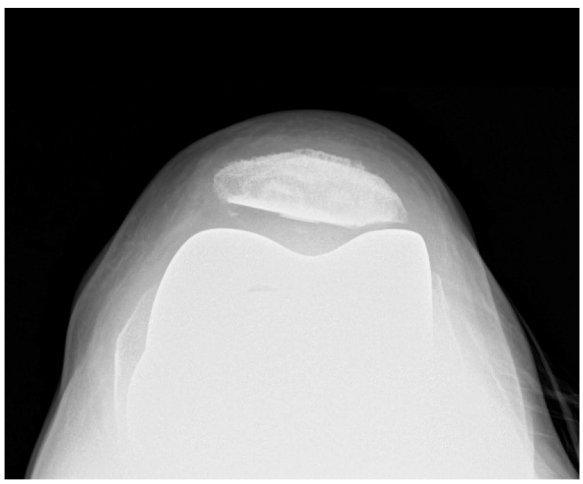

Figure 2. Example of a complication in the patellar resurfacing group with a conflict of the patella with the lateral condyle of the femoral component. In case of pain resistant to conservative treatment a lateral facetectomy, lateral retinacular release or revision patellar resurfacing might be considered.

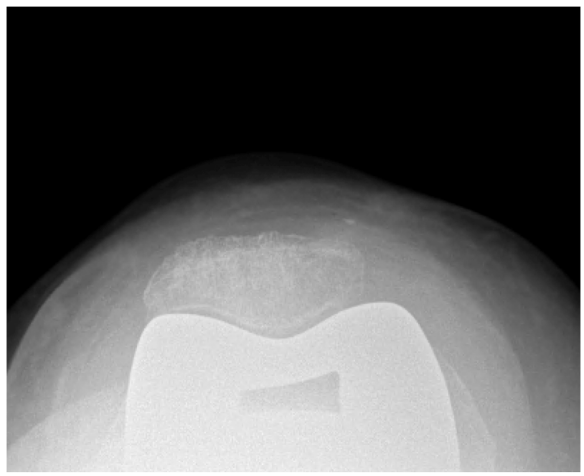

Figure 3. Example of a complication in the patellar nonresurfacing group with persistent anterior knee pain resistant to conservative treatment. Intraoperatively, there was confirmation of progressive patellar erosion, for which a patellar resurfacing was performed.

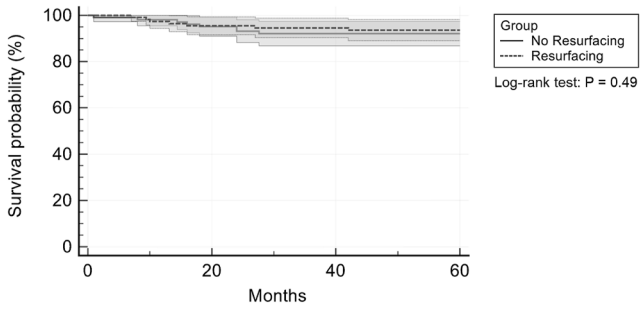

Figure 4. Kaplan–Meier curve analyzing the survival rates between the patellar nonresurfacing and the patellar resurfacing cohorts up to 5 years postoperatively. There was no difference in survival rates between both groups.

consistent with previous literature [29–31]. For example, Burnett et al. [32] reported no significant differences between PR and PNR in terms of KSS and knee range of motion in a randomized controlled trial with at least 10 years of follow-up, although with an older cruciate-retaining design. Similarly, Picart et al. [33] found no difference in Lille scores between resurfaced and nonresurfaced patellae at an average of two years postoperatively in a retrospective study with a modern implant. Both of these studies utilized bilateral TKA models to compare the outcomes of PR versus PNR. In contrast, other meta-analyses, including those limited to randomized studies and those combining randomized and nonrandomized trials, demonstrated the superiority of routine PR, showing a reduction in AKP and higher HSS and KSS scores than the nonresurfaced counterpart [34,35].

Despite the observed radiographic progression of PF OA in the PNR group, patient-reported outcomes, including pain and function, remained unaffected. The distribution of PF OA stages at five years showed a marked reduction in stage 0 cases (from 35.1% at two years to 8% at five years) and a corresponding increase in stages 1 to 4. However, despite the five secondary PRs in this study, the lack of significant differences in Kujala and Lille scores suggests that this progression did not lead to substantial clinical complaints. These findings align with previous literature indicating that radiographic worsening does not necessarily correlate with clinical symptoms, reinforcing the idea that routine PR may not be mandatory for all patients undergoing TKA [36]. Similar findings have been reported by Matassi et al., who noted that despite radiographic changes, patient satisfaction remained high regardless of nonresurfacing status.

The complication rates in both groups were low and comparable, with only four new complications that required reintervention occurring between two and five years postoperatively. These included PR for AKP and aseptic loosening in the PNR group, as well as one infection and one revision TKA for an unknown reason in the PR group. Previous studies have reported varying complication rates associated with PR, including patellar fractures, instability, and maltracking [37]. However, in our study, although there might be a trend toward statistical significance, which might be relevant for larger cohorts, there was no evidence to suggest a higher risk of revisions in either cohort, further supporting the safety of both surgical approaches. Similar findings have been documented in multiple studies that observed no significant differences in revision rates between resurfaced and nonresurfaced groups [38–41].

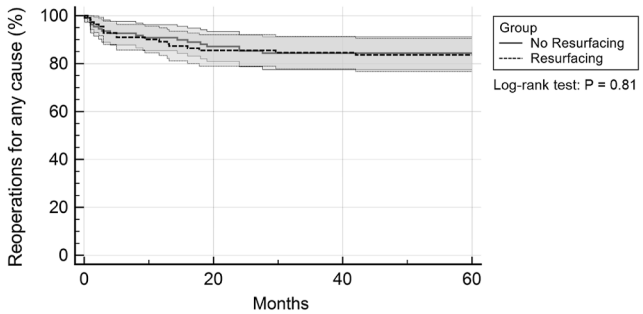

Figure 5. Kaplan–Meier curve analyzing the rate of reoperation for any cause between the patellar nonresurfacing and the patellar resurfacing cohorts up to 5 years postoperatively. There was no difference in reoperation rates for any cause between both groups.

The 5-year survival rates were equivalent between the PNR and PR groups, around 6 to 8% in both cohorts. This aligns with prior studies, which have shown that PR does not necessarily influence implant survival [42,43]. However, the revision rates of the current study are higher than several national joint registries with revision rates of 3 to 4% at even 10 years postoperatively [44,45]. The fact that the study was performed in a referral center for knee arthroplasty might have had an influence on the overall survival rates. As well, secondary PR was taken into account as a revision; this has increased the revision rates as well in the PNR cohort.

Conclusions

This study provides further evidence that routine PR does not offer a clear long-term clinical or functional advantage in TKA patients compared to no PR when using a posterior-stabilized, patella-friendly implant design.

Despite radiographic progression of PF OA in the PNR group, no significant impact on patient-reported outcomes was observed. Additionally, complication rates and survival outcomes remained comparable between both cohorts. These findings contribute to the ongoing debate regarding the necessity of PR and suggest that a selective approach may be justified, especially in the context of modern patella-friendly implant designs.

CRediT authorship contribution statement

Antoine Catteeuw: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Hannes Vermue:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Anaïs Lefeuvre:** Data curation. **Elvire Servien:** Writing – review & editing, Supervision, Resources, Conceptualization. **Cécile Batailler:** Writing – review & editing, Supervision, Resources, Methodology, Conceptualization. **Sébastien Lustig:** Writing – review & editing, Supervision, Resources, Methodology, Conceptualization.

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