



Patellar Resurfacing and Crepitation After Total Knee Arthroplasty, Propensity Score Matching

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Purpose: Patellar crepitation (PC) is a complication of posterior-stabilized total knee arthroplasty (PS-TKA). However, the role of patellar resurfacing (PR) in the reduction of PC remains controversial. This study aimed to evaluate the effectiveness of PR in reducing PC after PS-TKA.

Methods: This retrospective comparative study included patients aged 55–80 years with Kellgren–Lawrence grades 3–4 knee osteoarthritis who underwent PS-TKA. The patients were divided into resurfaced and non-resurfaced groups. Propensity score matching using sex, body mass index, age, preoperative Knee Society Score, and preoperative Feller score produced 89 matched patients per group. The primary outcome was the presence of patellar crepitus. Secondary outcomes included blood loss, radiographic patellar alignment, functional scores, and complications.

Results: The incidence of PC was significantly lower in the resurfaced group than that in the non-resurfaced group (15.7% vs. 77.5%, $p < 0.001$). The estimated blood loss was higher in the resurfaced group, but the difference was not clinically significant. Functional outcomes were comparable between groups, whereas the Feller knee score and patellar shift favored the resurfaced group.

Conclusions: PR significantly reduces PC and improves patellofemoral function after PS-TKA without increasing the complication rates.

Keywords: total knee arthroplasty, patellar resurfacing, patellar crepitation, posterior-stabilized knee, propensity score matching

Although total knee arthroplasty (TKA) is an effective surgical option for end-stage osteoarthritis (OA)⁽¹⁻²⁾, patellar crepitation (PC) remains a concern in posterior substitution TKA⁽³⁾. Anterior

knee pain and patellofemoral dysfunction are common TKA complications⁽²⁾. Several patellofemoral complications, such as PC or patella clunk syndrome, are unique to posterior-stabilized (PS)-TKA implantation, with an incidence ranging from 0–21%⁽⁴⁻⁷⁾.

The development of PC after PS-TKA is associated with numerous factors, including femoral component design with a high intercondylar box ratio⁽⁴⁻⁶⁾, increased femoral component flexion, use of a smaller femoral component, increased posterior femoral offset, decreased patellar compo-

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ment size, thinner patellar component, reduced patellar tendon length, and low Insall–Salvati ratio⁽⁸⁻⁹⁾. A substantial factor that may have affected PC occurrence is patellar resurfacing (PR). PR is performed to restore the proper coordination and movement of the patellofemoral joint⁽¹⁰⁾. However, there is no consensus regarding the necessity of PR. In a study by Deroche et al.⁽¹⁸⁾, no statistically significant differences were observed in functional score and anterior knee pain between PR and non-PR TKA, and routine resurfacing in TKA was not recommended. In contrast, a study by Thiengwittayaporn et al.⁽⁹⁾ revealed that PR TKA yielded better functional outcomes and less PC than non-PR TKA, and routine PR TKA was recommended.

Preliminary data from our institution revealed a notably high incidence of PC among patients who underwent non-PR TKA. Therefore, this study aimed to evaluate the effectiveness of PR in reducing the incidence of PC after PS-TKA.

METHODS

Study Design and Population

This was a clinical study with historical control in patients diagnosed with advanced-stage knee OA who underwent TKA. The study included patients aged 55–80 years with OA knee KL 3–4 who underwent TKA with patellar non-resurfacing between 2022 and 2024 (control group) and consecutive patients who underwent TKA with PR between July 2024 and June 2025. Patients diagnosed with secondary OA or patellar thickness <20 mm were excluded.

Group Allocation

The participants were allocated based on the study period. The historical control group (retrospective cohort) comprised patients who underwent non-PR TKA before July 2024. The intervention group (prospective cohort) comprised patients enrolled from July 2024 onwards.

Surgical Technique

All TKA procedures were performed by a single surgeon with a single implant (Vega), adhering to the general principles of using all-cemented, posterior-stabilized prostheses. Spinal

anesthesia with an adductor canal block was performed, and prophylactic antibiotics and tranexamic acid were administered preoperatively. After sterile preparation, a tourniquet was inflated. A medial parapatellar approach was used with a midline skin incision. Bone resection was performed using the gap-balancing technique starting with a tibial cut. The tightening structures were released before gap measurement, and the distal femur and anterior-posterior cuts were calculated from the extension and flexion gaps, respectively. Trial components were used to evaluate the extension–flexion gap balance. Patellar thickness was measured, and bone resection was performed with a minimum residual thickness of 13 mm. All patellae were resurfaced to match their original thickness, and the lateral cut surface was beveled using an electric saw. A dome-shaped patellar component was used, and patellofemoral articulation was evaluated using the no-thumb technique. Lateral retinacular release was only performed in patients with severe maltracking. Cement fixation was applied to all the components. Postoperative pain control and rehabilitation were standardized using a multimodal approach. Patients commenced isometric quadriceps exercises and straight leg raises on postoperative day 1, followed by active and passive range of motion (ROM) exercises twice daily for six weeks. Walking without gait aids was encouraged at 3–4 weeks postoperatively.

Outcome Measures

The patients were evaluated at two weeks, six weeks, three months, six months, and one year postoperatively. The presence of patellar crepitus, ROM, Knee society score (KSS), and Feller knee scores were evaluated at 12 months by another clinician who was blinded to the intervention. PC was considered present if a palpable, crunching, and grinding sensation over the patellar region was detected upon ranging the knee. Postoperative radiographic parameters were evaluated at six weeks using a picture archiving and communication system (Synapse Radiology version 5; Fujifilm Medical System, U.S.A.).

Statistical Analysis

Sample size calculation was based on the hypothesis that interventional procedures could decrease the rate of crepitation from 70% to 50%.

The power of study was 80% with $\alpha = 0.05$, and a two-sided significance level. The sample size was 103 in each group.

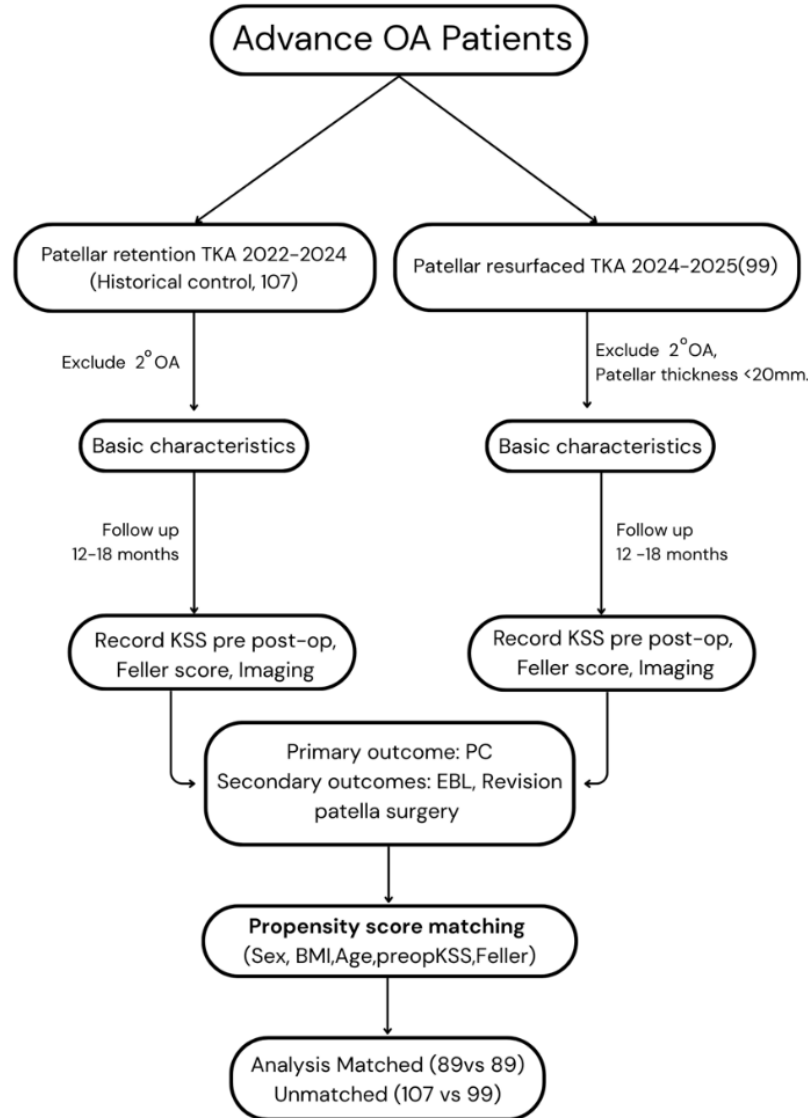


Fig. 1 Study flow. BMI, body mass index; EBL, estimated blood loss; KSS, Knee Society Score; OA, osteoarthritis; PC, patellar crepitation; TKA, total knee arthroplasty.

As the two treatment groups were not randomly assigned, confounding by indication and by contraindication may have been present and interfered with the genuine association between treatment and PC. Propensity score matching was applied to make a comparable contrast group. A multivariable logistic regression model that

derived the score from pretreatment characteristics may have influenced the physicians' choice of treatment. These characteristics included sex, age, body mass index (BMI), preoperative KSS, and preoperative Feller score. The matching yielded 89 patients in each group.

The demographic and preoperative data and clinical and radiographic outcomes of both groups were compared using Fisher's exact test and Student's t-test. Statistical significance was set at $p < 0.05$ (STATA version 16).

RESULTS

This study initially included 206 patients; 99 in the patellar resurfaced and 107 in the non-resurfaced groups. Significant baseline imbalances were observed between the two groups before matching regarding age (standardized mean difference (SMD) = 0.23), female sex (SMD = 0.18), and preoperative KSS (SMD = 0.12).

After stratified propensity score matching, a well-balanced cohort of 178 patients (89 pairs) was identified. The matching process successfully eliminated the initial selection bias, as evidenced by the following:

Sex balance: The proportion of women was identical in both groups (87.6% vs. 87.6%, SMD = 0).

Age and clinical scores: The SMD for age significantly improved from 0.23 to 0.05, and preoperative KSS score improved from 0.12 to 0.02.

Overall balance: All covariates, including BMI and preoperative Feller score, achieved an SMD of <0.1 , indicating that the two groups were highly comparable for subsequent outcome analysis.

Table 1 Baseline characteristics of patients before and after propensity score matching.

| Characteristics | Unmatched | | | Matched | | |
|--------------------------|----------------------------------|---------------------------------------|------|----------------------------------|--------------------------------------|------|
| | Resurfaced (n=99), mean±SD | Non-resurfaced (n=107), mean±SD | SMD | Resurfaced (n=89), mean±SD | Non-resurfaced (n=89), mean±SD | SMD |
| Female, n (%) | 83 (83.8) | 96 (89.7) | 0.17 | 78 (87.6) | 78 (87.6) | 0 |
| Age (years) | 65.9±5.9 | 64.5±6.5 | 0.23 | 65.5±5.8 | 65.8±6.1 | 0.05 |
| BMI (kg/m ²) | 27.3±4.1 | 27.1±4.0 | 0.04 | 27.3±4.3 | 27.4±3.8 | 0.02 |
| Preop KSS (point) | 32.9±13.5 | 34.5±13.0 | 0.12 | 33.3±13.1 | 33.6±12.8 | 0.02 |
| Preop Feller score | 12.6±3.0 | 12.7±3.0 | 0.02 | 12.6±2.9 | 12.7±3.1 | 0.01 |

BMI, body mass index; KSS, knee society score; SD, standard deviation; SMD, standardized mean difference

After propensity score matching, the resurfaced group demonstrated significantly superior clinical results regarding the primary outcomes compared with the non-resurfaced group. The incidence of patellofemoral crepitus was significantly lower in the resurfaced group at both follow-up intervals. At six months, crepitus occurred in only 9.0% (8/89) of the resurfaced group compared with 33.7% (30/89) of the non-resurfaced

group. This difference was even more pronounced at 12 months, with 15.7% (14/89) in the resurfaced group and 77.5% (69/89) in the non-resurfaced group (risk difference; -61.8%, $p < 0.001$). The resurfaced group had a higher mean estimated blood loss (557.9 ± 25.0 mL) than the non-resurfaced group (465.2 ± 20.6 mL), with a mean difference of 92.7 mL ($p = 0.005$).

Table 2 Primary outcomes of patients after propensity score matching.

| Outcomes | Resurfaced (n=89) | Non-resurfaced (n=89) | Risk difference (95% CI) | p-value |
|-------------------|----------------------|--------------------------|-----------------------------|---------|
| Crepitus, n (%) | | | | |
| 6 months | 8 (9.0) | 30 (33.7) | -24.7 (-36.2, -13.2) | <0.001 |
| 12 months | 14 (15.7) | 69 (77.5) | -61.8 (-73.3, -50.3) | <0.001 |
| EBL (mL), mean±SE | 557.9±25.0 | 465.2±20.6 | 92.7 (28.8, 156.6) | 0.005 |

CI, confidence interval; EBL: estimated blood loss; SE: standard error

Clinical improvement and radiographic alignment were analyzed as secondary outcomes, and the resurfaced group showed a significantly higher improvement in clinical scores. The KSS difference (postoperative minus preoperative) was 50.2 ± 14.3 and 40.7 ± 16.1 points in the resurfaced and non-resurfaced groups, respectively ($p < 0.001$). The Feller score difference was significantly higher in the resurfaced group (16.1 ± 3.2 vs. 12.5 ± 4.5 , $p < 0.001$). The patella shift showed significant

difference, with lower values detected in the resurfaced group (1.4 ± 1.7 mm) compared with those in the non-resurfaced group (2.2 ± 1.8 mm, $p = 0.002$). No significant differences were observed between both groups regarding ROM ($p = 0.175$), Insall–Salvati ratio ($p = 0.325$), or patellar tilt angle ($p = 0.227$).

No patellar complications, such as patellar fracture, dislocation, or early component loosening, were observed in the resurfaced group.

Table 3 Secondary outcomes of patients after propensity score matching.

| Outcomes | Resurfaced (n=89), mean±SD | Non-resurfaced (n=89), mean±SD | Difference (95% CI) | p-value |
|-----------------------------|-------------------------------|-----------------------------------|------------------------|---------|
| KSS difference | 50.2 ±14.3 | 40.7±16.1 | 9.5 (5.0, 14.0) | <0.001 |
| Feller difference | 16.1±3.2 | 12.5±4.5 | 3.6 (2.5, 4.8) | <0.001 |
| ROM | 122.4±8.1 | 123.9±6.6 | -1.5 (-3.7, 0.7) | 0.175 |
| Insall-Salvati ratio | 1.17±0.14 | 1.15±0.13 | 0.02 (-0.02, 0.06) | 0.325 |
| Patella tilt angle (degree) | 6.3±5.3 | 7.3±5.1 | -0.9 (-2.5, 0.6) | 0.227 |
| Patella shift (mm) | 1.4±1.7 | 2.2±1.8 | -0.8 (-1.4, -0.3) | 0.002 |

SD, standard deviation; SE, standard error; ROM, range of motion; KSS, Knee Society score.

DISCUSSION

Notably, PR significantly reduced the incidence of PC in patients undergoing PS-TKA using the Vega system. The results demonstrated reduced PC from 77.5% in the non-resurfaced group to 15.7% in the resurfaced group at 12 months postoperatively. Furthermore, the necessity of routine PR remains debated in orthopedic literature. Our findings align with those of Thiengwittayaporn et al.⁽³⁾, who reported that PR in PS-TKA significantly reduced PC and led to better functional outcomes. However, although overall functional scores (KSS) may appear equivalent in some studies, the risk of secondary surgery due to persistent patellofemoral symptoms is often higher in non-resurfaced cohorts. As demonstrated in the knee arthroplasty trial (a multicenter randomized control trial)⁽¹⁴⁾, patients who did not undergo resurfacing faced a higher revision burden, a concern that was mitigated by the routine PR approach evaluated in our study. In our cohort, although the Feller score and KSS difference showed statistically significant improvements favoring the PR group ($p < 0.001$), the mean differences may not have reached the minimum

clinically important difference (MCID). This suggests that, although the surgeon can detect improvement in patellofemoral function, the patient's subjective experience regarding overall function might not be satisfactory. Conversely, the statistically higher estimated blood loss in the PR group (92.7 mL difference) was clinically negligible. None of the patients in the PR group required additional transfusions or experienced resurfacing-related complications, such as patellar fracture or component loosening. The mechanical and radiographic insights and improved outcomes in the PR group may be attributed to better radiographic patellar alignment. Our study found a significantly lower patellar shift in the resurfaced group compared with that in the non-resurfaced group (1.4 mm vs. 2.2 mm, $p = 0.002$). Proper restoration of patellar thickness and the use of a dome-shaped component likely contributed to a more stable patellofemoral tracking, thereby reducing the mechanical friction that causes crepitus. Evidence on the Vega PS-TKA design is relatively limited. Although Gerdesmeyer et al.⁽¹⁷⁾ reported favorable midterm outcomes, their study noted that approximately 8% of patients eventually

required secondary PR. Our study reinforces the recommendation for routine PR when using the Vega PS-TKA to prevent late patellofemoral complaints and ensure optimal early outcomes.

Limitations

First, this study used a historical control group for the non-resurfaced cohort (2022–2024), whereas the resurfaced group was prospectively enrolled (2024–2025). Despite propensity matching, temporal factors or subtle evolutions in perioperative care during these periods may have influenced the outcomes.

Second, the current analysis focused on short-to-medium-term outcomes (12–18 months). Since PC can sometimes manifest or change in characteristics beyond the first year, a longer follow-up period would be beneficial for assessing the long-term durability of these results.

Third, although the study was powered to detect differences in crepitation, the matched sample size of 89 pairs may be insufficient to identify statistically significant differences in rare but serious complications, such as patellar fractures, component loosening, or the need for revision surgery.

Finally, although improvements in the KSS and Feller scores were statistically significant, the mean differences may not have reached the established MCID, suggesting that some statistical gains may not translate into a perceptible difference for every patient.

CONCLUSIONS

PR in PS-TKA significantly reduces PC and improves patellofemoral parameters without clinical relevance to functional outcomes. Routine PR should be considered during Vega PS-TKA.

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