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Original Article

# Patellar resurfacing in total knee arthroplasty leads to better isokinetic performance

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A R T I C L E I N F O

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A B S T R A C T

*Background:* For decades there have been concerns about patellar resurfacing (PR) in total knee arthroplasty (TKA) and the individual preference of the surgeon is still the main determinant of whether or not resurfacing is applied. According to preference, surgeons can be categorized in 3 main groups of those who usually, selectively, or rarely resurface. The aim of this prospective, randomized, controlled study was to compare the isokinetic performance and clinical outcome of TKAs with PR and without PR.
*Methods:* A total of 50 patients scheduled to undergo TKA for primary osteoarthritis of the knee were randomly assigned to either the PR or non-PR groups. There were no significant differences between the groups in respect of age, BMI, gender and preoperative Knee Society Score (KSS) and isokinetic performance. Patients were evaluated at postoperative 3, 6, and 12 months with KSS and at 6 months and 1 year with isokinetic measurements.
*Results:* The PR group had a higher mean score, especially in the functional component of KSS, but the difference was not statistically significant. Knee extension peak torque was significantly higher in the PR group at 6 months ($p = 0.029$) and 1 year ($p = 0.004$) postoperatively. There were no significant differences between the groups in respect of knee flexion peak torque values following TKA.
*Conclusions:* The results of this study demonstrated that PR during TKA is associated with better isokinetic performance and higher knee scores. These results support routine/usually resurfacing of the patella. For surgeons who selectively resurface the patella, the advantage of better isokinetic performance may be taking into consideration in favor of resurfacing the patella where they are undecided.
*Level of evidence:* Level I, therapeutic study.


## 1. Introduction

Patellar resurfacing remains a controversial issue after more than four decades of total knee arthroplasty (TKA) and no consensus has been reached on the optimal patella resurfacing strategy [1,2]. Recent prospective, randomized controlled trials (RCTs) and meta-analyses have suggested that patellar resurfacing may have several advantages such as less anterior knee pain, higher knee scores, more overall satisfaction and avoidance of secondary resurfacing [3–6]. On the contrary, opponents have claimed that no difference in knee pain, knee scores, and patient satisfaction should be expected; but there is an increase in implant-related complications and avascular necrosis of the patella after patellar resurfacing [3,7,8].

These confusing meta-analysis and research studies have not been able to reach clear conclusions and therefore cannot provide an optimal algorithm or strategy for patellar resurfacing in routine practice of the surgeons. All previous studies have concluded that there is a need for further high quality prospective, randomized, controlled studies. Alterations in the geometry of the patella affect the kinematics and loading of the patellofemoral joint and an increase in quadriceps efficiency allows the quadriceps to extend the knee with less force [9]. Quadriceps muscle strength is an important predictor of functional abilities in TKA [10] and isokinetic modality has been shown to be valid and reliable in assessment of the quadriceps muscle in these patients [11].

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Therefore, isokinetic performance was used as the primary outcome in this study to objectively evaluate knee function after TKA and the clinical scores of the patients were also evaluated. To the best of our knowledge, no prospective randomized controlled study has compared the isokinetic performance of knees with patellar resurfacing and non-resurfacing after TKA. The hypothesis of the present study was that compared with the non-resurfacing of the patella, patellar resurfacing would be associated with a better clinical outcome and isokinetic performance following TKA.

## 2. Materials and methods

Approval for this prospective, randomized comparison study was granted by the Local Ethics Committee and CONSORT (Consolidated Standards of Reporting Trials) guidelines were followed thereafter (Fig. 1). Written informed consent was obtained from all patients. Patients aged 55–80 years, scheduled to undergo unilateral primary total knee arthroplasty for primary osteoarthritis were included in the study following preoperative KSS evaluation and isokinetic measurements. Those with bilateral osteoarthritis, inflammatory arthritis, post-traumatic osteoarthritis, previous knee surgery and neuromuscular diseases were excluded. Patients meeting the criteria were randomized before the operation by a senior resident generating random numbers with Microsoft Excel 2016 (Microsoft Corporation, Seattle, WA, USA) into two groups as patellar resurfacing and non-patellar resurfacing. The patients and physiatrists performing the isokinetic measurements were blinded to the group allocations.

All surgeries were performed by the two senior surgeons one of whom always resurfaced the patella and the other who did not resurface. Both senior surgeons used posterior cruciate ligament substituting total knee replacements of the Vanguard® Complete Knee System prosthesis (Zimmer Biomet Inc., Warsaw, IN, USA). Apart from the patellar resurfacing, the same surgical technique was used by these two senior surgeons of the department. A tourniquet was inflated to pressure of 300 mmHg and straight, longitudinal midline skin incision and medial parapatellar arthrotomy were performed. During the bone cuts, mechanical alignment was used and clinical epicondylar axis was the determinant of the femoral rotation in both groups. Patella thickness was measured by caliper, amount of patella resection was determined by the thickness of patellar implant to restore original patella thickness to prevent overstuffing of the patellofemoral joint in the resurfacing group. The femoral, tibial and patellar components (in the resurfacing group) were implanted with pressured bone cement (Fig. 2). A suction drain was placed inside the knee capsule; the overlying layers were closed in the anatomical planes. Morning of the first day after surgery, the Jones bandage and suction drain were removed, and patients were mobilized under supervision of the physiotherapist. All patients underwent the same rehabilitation

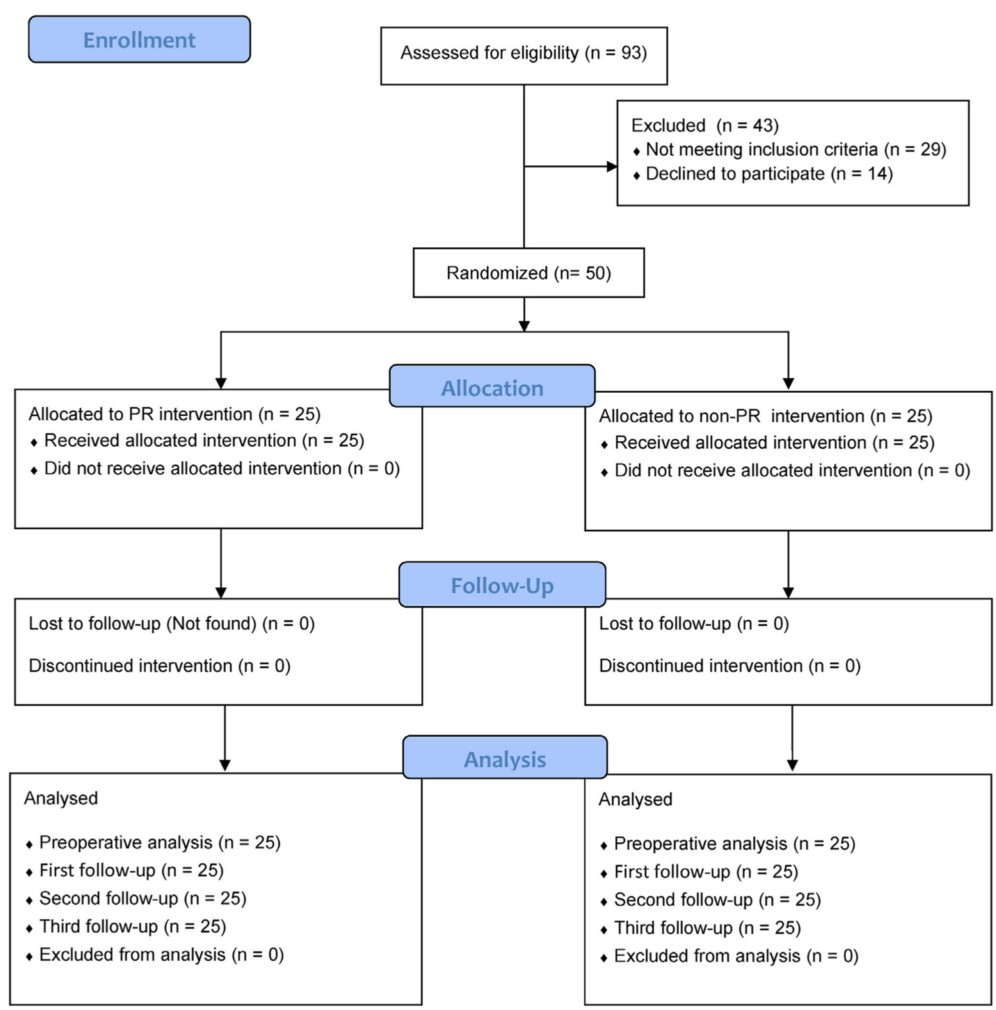


**Fig. 1.** CONSORT (Consolidated Standards of Reporting Trials) diagram. PR = Patellar Resurfacing, non-PR = non-Patellar Resurfacing.

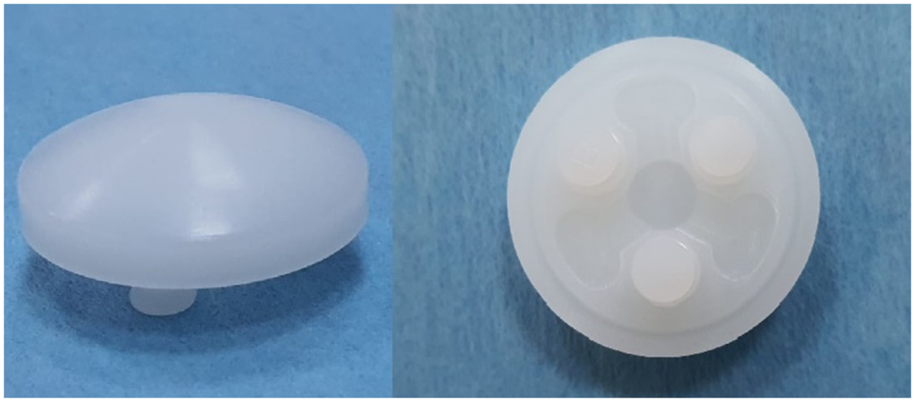

**Fig. 2.** Anterior and posterior views of the dome shaped three-peg patellar component of Vanguard® Complete Knee System prosthesis (Zimmer Biomet).

procedure during the outpatient period, supervised by the same physiotherapist. In regular follow-up, patients underwent KSS assessment at postoperative 3, 6, and 12 months, and isokinetic measurements at 6 and 12 months.

Isokinetic measurements were performed with a Biodex System III Isokinetic Dynamometer, version 3.03 (Biodex Medical Inc.,Shirley, NY, USA). Patients were positioned on the dynamometer with the hip in 90° in a sitting position for knee flexion and extension measurements. Lateral movement of the knee was prevented during the full extension and flexion of the knee by a thigh strap on the operated leg. The physical therapist helped the patients to achieve proper positioning before each test. Concentric isokinetic knee flexion–extension was assessed at a preset velocity of 60°/sec, over a range of motion of 0° to 110° for both parameters. A fixed number of 10 flexion–extension repetitions were completed by each patient. The instructions were provided once more, and one more trial repetition was performed by all patients before the last baseline muscle strength measurements were taken. The estimated intraclass correlation coefficients for the intra-observer reliability of the peak extensor torque and peak flexor torque were 0.826 and 0.818, respectively.

Regarding to the power analysis of the current study, sample size estimation was performed using the knee extension peak torque as a primary effect variable. As there is no similar study on this subject with isokinetic measurements, a difference in mean values of 8 Nm and standard deviation of 8 Nm were assumed for each group. Group sample sizes of 22 and 22 achieved a power of 0.90 to detect a difference of 8 Nm between the two groups with estimated group standard deviations of 8 Nm for each group and with a significance level (alpha) of 0.05 using a two-sided, two-sample test. Considering loss to follow-up, 3 patients were added to each group and the study included 25 patients in each group. All data for continuous variables were calculated as mean and standard deviation values. The Student's t-test and the Chi-square test were used for statistical comparison. Data obtained in the study were analyzed statistically using SPSS.22.0 software (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY, USA). The alpha value was set at <0.05 statistical significance for all tests.

## 3. Results

The study initially included a total of 50 patients, as 25 in each group. Postoperative complications developed of one superficial infection and two symptomatic deep vein thrombosis, all of which were cured with drug treatment. The superficial infection was seen in the PR group and of the two cases of symptomatic deep vein thrombosis, one was from the PR group and one was from the non-PR group. The groups were similar in respect of age, gender, body mass index distribution, ASA physical status and Kellgren–Lawrence grade of tibio-femoral joint and patella-femoral joint (Table 1).

Preoperative and 12th month follow-up mean range of motion (ROM) of PR group were 109.8 and 118.9 respectively. Preoperative and 12th month follow-up ROM of non-PR group were 112.2 and 119.8 respectively. There was no difference between groups regarding the preoperative ($p = 0.455$) and postoperative ($p = 0.626$) ROM degrees. Means of the operation time and blood loss of PR group were 86.7 min and 249.8 ml respectively. Means of the operation time and blood loss of non-PR group were 84.9 min and 220.3 ml respectively. Considering the operation time ($p = 0.455$) and blood loss ($p = 0.626$), there was no difference between groups. Mean hip-knee-ankle angles (HKA) of the PR and non-PR group were 1.68 and 2.12 respectively and there was no difference ($p = 0.305$).

Both groups experienced significant improvements in KSS-knee and KSS-function scores throughout the follow-up period. The PR group had higher mean scores, especially in the functional component of KSS, but this difference was not statistically significant ($p > 0.05$). The preoperative and postoperative KSS-knee and KSS-function scores are shown in Table 2 and Table 3 respectively. Knee extension peak torque was significantly higher postoperatively in the PR group at postoperative 6 months ($p = 0.029$) and 1 year ($p = 0.004$) (Table 4). There were no significant differences between the groups in respect of knee flexion peak torque values following TKA (Table 5).

## 4. Discussion

As TKA has become one of the major surgeries in orthopedic practice, the influence of the components and their design on postoperative results has become a matter of debate. Tibial insert

**Table 1**
Demographic data of the patients.

| | PR group | non-PRgroup | p Value |
|---|---|---|---|
| Gender (n) | | | 0.417 |
| Female | 20 | 23 | |
| Male | 5 | 2 | |
| Age (years) | 68.36 ± 7.61 | 71.80 ± 8.42 | 0.136 |
| BMI (kg/m$^2$) | 31.09 ± 3.87 | 29.55 ± 3.28 | 0.138 |
| ASA Physical Status | 2.12 ± 0.78 | 2.36 ± 0.64 | 0.240 |
| Kellgren–Lawrence Grade (I-II/III-IV) | | | |
| Tibio-femoral joint | 3/22 | 1/24 | 0.609 |
| Patella-femoral joint | 19/6 | 16/9 | 0.538 |

The values are given as mean and standard deviation values.

**Table 2**
Preoperative and follow-up knee outcomes of KSS.

| | PR group | non-PRgroup | p Value |
|---|---|---|---|
| Preoperative | 49.04 ± 11.91 | 48.04 ± 14.52 | 0.791 |
| Month 3 | 78.81 ± 11.73 | 79.48 ± 10.80 | 0.811 |
| Month 6 | 88.52 ± 6.91 | 86.76 ± 7.39 | 0.389 |
| Month 12 | 93.48 ± 5.15 | 90.92 ± 5.87 | 0.108 |

The values are given as mean and standard deviation values.

**Table 3**
Preoperative and follow-up functional outcomes of KSS.

| | PR group | non-PRgroup | p Value |
|---|---|---|---|
| Preoperative | 50.52 ± 10.97 | 49.16 ± 14.18 | 0.706 |
| Month 3 | 64.47 ± 14.19 | 65.73 ± 11.90 | 0.699 |
| Month 6 | 74.36 ± 10.03 | 71.88 ± 12.47 | 0.442 |
| Month 12 | 85.24 ± 10.22 | 81.48 ± 11.18 | 0.221 |

The values are given as mean and standard deviation values.

**Table 4**
Preoperative and follow-up peak extensor torque scores of the operated knee.

| | PRgroup | non-PRgroup | p Value |
|---|---|---|---|
| Preoperative | 57.60 ± 9.25 | 56.32 ± 9.33 | 0.628 |
| Month 6 | 59.96 ± 9.63 | 54.48 ± 7.47 | 0.029 |
| Month 12 | 66.64 ± 9.90 | 58.72 ± 8.61 | 0.004 |

The values are given as mean and standard deviation values (Nm).

**Table 5**
Preoperative and follow-up peak flexor torque scores of the operated knee.

| | PR group | non-PRgroup | p Value |
|---|---|---|---|
| Preoperative | 40.84 ± 8.46 | 38.12 ± 9.92 | 0.302 |
| Month 6 | 35.76 ± 8.39 | 36.72 ± 10.14 | 0.707 |
| Month 12 | 41.04 ± 8.22 | 40.52 ± 10.43 | 0.846 |

The values are given as mean and standard deviation values (Nm).

and patellar component are the polyethylene components of TKA and while the effect of the tibial insert type on postoperative results has become a matter of debate [12–14], the decisions about the use or not of the patellar component are more complex [1,8,15–23]. The individual preference of the surgeon is still the main determinant of patellar resurfacing and great differences are seen between countries. However, worldwide trends have changed little over the past decade and while patellar resurfacing is performed in >80% of TKAs, most countries outside the USA continue to resurface at a much lower percentage [2].

Many meta-analyses and cost-effectiveness analysis studies have aimed to resolve this concern of whether or not to resurface, which deeply divides the orthopedics community. A recent cost-effectiveness analysis demonstrated that it was not cost-effective to routinely resurface the patella and selective resurfacing was recommended [15]. However, Weeks et al. reported higher costs ($13,296.63 vs $12,917.01) of not resurfacing the patella and concluded that resurfacing was superior to retention of the patella [16]. Although two meta-analyses have reported lower knee pain and higher knee scores [4,17], others have found no difference in knee pain and knee scores and concluded that there is no clear superiority of patellar resurfacing compared to patellar retention [7]. A meta-analysis of 16 RCT reported that 9 studies were unable to define a clinically significant difference between resurfacing and non-resurfacing in respect of patient function and perception of pain, two studies showed a slight preference towards non-resurfacing, whilst the results of five studies were in favor of resurfacing over non-resurfacing [3].

A retrospective study with a minimum 10-year follow-up period reported no significant difference between patellar resurfacing and non-resurfacing in respect of the long-term clinical outcomes and survival [18], whereas other retrospective studies have reported results in favor of resurfacing [19]. Two recent well-designed RCTs reported lower postoperative knee scores for non-resurfaced patella cases and concluded that patellar resurfacing was superior [20,21], whereas other RCTs have reported no difference in knee scores and concluded that patellar resurfacing had no beneficial effect and seemed unnecessary [22]. Surprisingly, in a recent very well-designed RCT of 129 knees with three years of follow-up, Aunan et al. reported that the mean subscores for the knee injury and osteoarthritis outcome score (KOOS) after surgery were statistically significantly in favor of patellar resurfacing and there were no statistically significant differences in the KSS, Oxford knee score (OKS) and visual analog scale (VAS) for patient satisfaction [23]. There is another recent single-centered prospective RCT reporting no difference in KSS, forgotten joint score, anterior knee pain, pain when climbing stairs, patellar tilt, and patellar translation [24]. No superiority of patellar resurfacing or non-resurfacing in terms of clinical or radiological outcomes at mid-term was concluded in this study. These confusing meta-analysis and research studies have not been able to reach clear conclusions and therefore cannot provide an optimal algorithm or strategy for patellar resurfacing in routine practice of the surgeons. All previous studies have concluded that there is a need for further high quality prospective, randomized, controlled studies.

Quadriceps muscle strength is an important predictor of functional abilities in patients undergoing TKA [10]. In terms of isokinetic testing, peak power across isokinetic velocities and isotonic resistances were correlated with the functional performance measures for the TKA patients and measurements of knee extensor power may be a useful tool for clinicians when assessing and setting milestones during rehabilitation [25]. Furthermore, isokinetic testing has been shown to provide valid and reliable data for the assessment of quadriceps strength in patients after TKA and from a practical point of view, quadriceps strength testing has been concluded to be reliable for use in both clinical practice and research settings [11]. Therefore, in the current study, isokinetic testing was used as an objective parameter to evaluate functional differences between patellar resurfacing and non-resurfacing. Taking soft tissue healing and functional recovery into consideration, isokinetic performance was evaluated at 6 months and 1 year after surgery in the present study. Quadriceps and hamstring muscle strengths showed the greatest decreases 3 months after TKA and decrease in quadriceps muscle strength was significantly greater than decrease in hamstring muscle strength [26]. Therefore, quadriceps muscle strength was suggested to be main focus in early rehabilitation after TKA and this finding supports the importance of our results regarding the knee extensor peak torque. Quadriceps and hamstring muscle strengths were shown to recover to preoperative level after six months [26] and this report is compatible to the results of the current study. To the best of our knowledge, no previous prospective, randomized, double-blind study has compared isokinetic performance differences between knees with patellar resurfacing and non-resurfacing in TKA. The results demonstrated that patellar resurfacing led to better isokinetic performance of the knee. This finding of the present study is clinically useful for surgeons in terms of selecting either the resurfacing or non-resurfacing strategy during TKA.

There are some limitations to this study. First, the patients in the present study had primary knee osteoarthritis, and cases of knee osteoarthritis secondary to other disorders such as rheumatological disorders were not evaluated. The use of an additional system such as computer-assisted surgery and navigation-assisted gap balancing technique may also influence the results. Moreover, dome component design was compared in the current study, so, the conclusions drawn from the current study cannot be applied to the comparison of the anatomic component design with the patellar non-resurfacing. Radiographical evaluation for patella alignment after TKA such as patella tilt, patella translation and patella height were not done. Surgeons differed between PR and non-PR group and it might influence the result. Finally, this study evaluated the results of TKA using the patellar component of only one company and patellar component designs of other companies should be evaluated to reach more generalizable results.

## 5. Conclusion

The results from this RCT imply that non-resurfacing the patella during TKA places the patient at risk of worse isokinetic performance which can lead to an inferior ultimate outcome. Surgeons who selectively resurface the patella may be undecided between two strategies in some cases. When determining whether to apply patellar resurfacing or not, the advantage of better isokinetic performance may be taking into consideration in favor of resurfacing the patella especially for surgeons who selectively resurface the patella.

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## Ethical approval

File Number: E-17-1414.

## Trial registration number and date of registration

ClinicalTrials.gov NCT04637490 (Retrospectively registered).

## Level of evidence

Level I – Randomized controlled trial.

## Declaration of competing interest

The authors declare that they have no conflict of interest.

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