Impact of Patellar Thickness in Total Knee Arthroplasty: Clinical and Functional Outcomes and Early Complications

Leonel Pérez Alamino, María Agustina Oláran, Germán Garabano, César Á. Pesciallo
Orthopedics and Traumatology Service, Hospital Británico de Buenos Aires, Autonomous City of Buenos Aires, Argentina

ABSTRACT

Introduction: Total knee arthroplasty (TKA) is effective in restoring function in patients with knee osteoarthritis. Restoration of the native patellar thickness is a critical aspect, but there is no consensus regarding the optimal thickness. The aim of this study was to evaluate the impact of patellar thickness on clinical and functional outcomes, radiological findings, complications, and revision rates in patients undergoing primary TKA. **Materials and Methods:** We conducted a retrospective study of patients who underwent TKA for primary osteoarthritis, with patellar resurfacing, and a minimum follow-up of 24 months. Recorded data included age, sex, body mass index, alignment, preoperative and postoperative patellar thickness, anterior knee pain, Knee Society Score (KSS), Visual Analog Scale (VAS) for pain, complication rates, and revision rates. **Results:** The series included 44 patients (mean age, 70.4 ± 10.8 years), all treated with the same prosthesis model. KSS, VAS, and anterior knee pain scores improved significantly. No significant differences were found between preoperative and postoperative patellar thickness (22.6 ± 2.9 mm vs. 22.0 ± 1.5 mm; p = 0.09). Postoperatively, 15.9% of patients had the same thickness as before surgery, while differences of 1 mm, 2 mm, and 3 mm were observed in 45.5%, 29.5%, and 9.1% of patients, respectively. **Conclusion:** Patellar thickness did not significantly influence clinical or functional scores, complication rates, or revision rates following primary TKA.

Keywords: Total knee arthroplasty; knee replacement; patellofemoral joint; patellar thickness.
Level of Evidence: IV

Impacto del grosor rotuliano en una artroplastia de rodilla. Análisis clínico-funcional y complicaciones tempranas

RESUMEN

Introducción: La artroplastia de rodilla es efectiva para restaurar la función en pacientes con artrosis de rodilla. Un aspecto crítico es la restauración del grosor rotuliano nativo. No hay consenso sobre el grosor rotuliano óptimo en la artroplastia de rodilla. El objetivo de este estudio fue evaluar el impacto del grosor rotuliano en los resultados clínico-funcionales y radiológicos, las complicaciones y la revisión, en pacientes sometidos a una artroplastia total de rodilla. **Materiales y Métodos:** Estudio retrospectivo de pacientes con una artroplastia de rodilla por gonartrosis primaria, con reemplazo del componente rotuliano y un seguimiento mínimo de 24 meses. Se registraron los siguientes datos: edad, sexo, índice de masa corporal, alineación, grosor rotuliano pre y posoperatorio, dolor anterior de rodilla, KSS y puntaje de la escala analógica visual de dolor, tasas de complicaciones y revisión. **Resultados:** La serie incluyó a 44 pacientes (edad media 70.4 ± 10.8 años) operados con el mismo modelo de prótesis. El KSS y los puntajes de la escala analógica visual y de dolor anterior de rodilla se incrementaron significativamente. No hubo diferencias significativas entre los grosores rotulianos pre y posoperatorio (22,6 ± 2,9 vs. 22,0 ± 1,5 mm; p = 0,09). El 15,9% tenía el mismo grosor posoperatorio que antes de la cirugía. En el 45,5%, 29,5% y 9,1%, la diferencia era de 1, 2 y 3 mm, respectivamente. **Conclusión:** El grosor rotuliano no tuvo un impacto significativo en los puntajes clínico-funcionales, las tasas de complicaciones o revisión tras una artroplastia total de rodilla primaria.

Palabras clave: Artroplastia total de rodilla; reemplazo de rodilla; articulación rotulofemoral; grosor rotuliano.
Nivel de Evidencia: IV

Received on April 2nd, 2025. Accepted after evaluation on July 13th, 2025 • Dr. LEONEL PÉREZ ALAMINO • leonelp95@gmail.com https://orcid.org/0000-0002-1563-6947

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INTRODUCTION

Total knee arthroplasty (TKA) is an effective procedure for relieving pain and restoring function in patients with advanced knee osteoarthritis. In Argentina, the prevalence of knee osteoarthritis is significant, leading to a substantial number of TKAs performed each year.[1,2] A critical aspect of TKA is the management of the patellofemoral joint, in particular decisions regarding patellar resurfacing and restoration of native patellar thickness.[3]

The patella plays a fundamental role in knee biomechanics, and alterations in its thickness can influence patellofemoral joint pressures and affect postoperative outcomes. Some studies have shown that deviations from native patellar thickness can impact patients' perception of outcomes and knee range of motion.[4] Conversely, other research suggests that minor increases in patellar thickness may not significantly affect knee flexion angles or functional outcomes.[5] Despite these findings, there is still no consensus on the optimal approach to restoring patellar thickness during TKA.

The variable results reported underscore the need for further research to establish standardized guidelines. It is important to note that there are limited data on Latin American populations, including Argentina, where anatomical factors and lifestyle habits may influence surgical outcomes differently.[6,7] Addressing this gap is essential to develop tailored surgical strategies that improve patient satisfaction and functional outcomes in these regions.

Therefore, the purpose of this study was to evaluate the impact of patellar thickness on clinical-functional and radiological outcomes, as well as complication and revision rates, in patients undergoing TKA for primary knee osteoarthritis.

MATERIALS AND METHODS

We conducted a retrospective study of patients operated on consecutively by the same surgeon at a high-volume TKA center between January 2021 and January 2023. We included patients who underwent primary TKA for severe knee osteoarthritis, received patellar component resurfacing, and completed a minimum follow-up of 24 months. We excluded patients with prior surgery or fractures of the treated knee; diseases such as rheumatoid arthritis or oncologic conditions; or varus/valgus malalignment >20°.

The U2 Knee™ design (United Orthopedic Corporation, Taiwan) was used in all cases. During the study period, 49 patients underwent surgery; 5 (10.2%) were excluded (3 due to prior surgeries and 2 due to rheumatoid arthritis treated with prolonged corticosteroids). The final series comprised 44 patients with a mean follow-up of 53.6 ± 2.4 months. Table 1 summarizes the variables of included patients.

From institutional medical records, we extracted age, sex, operated side, body mass index, range of motion, tourniquet use, and follow-up time.

Surgical Technique

All patients were operated on in the supine position under hypotensive spinal anesthesia, in a laminar-flow operating room, with a tourniquet at the proximal thigh. Cefazolin 1 g (2 g if weight >80 kg) was administered as antibiotic prophylaxis 30 minutes before skin incision. In all cases, a midline anterior approach with a medial parapatellar arthrotomy was used. Soft tissues were then released and balanced to correct deformity according to the mechanical axis (varus/valgus).

After the tibial and femoral cuts were made, patellar thickness was recorded manually with a caliper before the osteotomy, immediately afterward (remaining bony patellar thickness) (Figure), and with the trial polyethylene button, respectively. Stability and tracking were assessed using the trial components. If tracking was inadequate, a lateral retinacular release was performed; if the issue persisted, component rotation was re-evaluated. Before cementing the definitive components, proper patellar tracking throughout the full range of flexion–extension was confirmed.

For final fixation, one dose of high-viscosity bone cement was used per component.

The extensor mechanism was closed with 2-0 Vicryl® using separate figure-of-eight stitches.

All patients followed the same rehabilitation protocol. On postoperative day 1, emphasis was placed on quadriceps and calf isometric exercises, along with sitting at the edge of the bed. On day 2, assisted ambulation with a walker or Canadian crutches began and continued until week 3. If tolerated, patients were instructed to use a cane between weeks 3 and 6, and then to continue unaided.

Table 1. Variables of the patients included in the analysis

Variable	n = 44
Age (mean, SD)	70.4 ± 10.8
Gender n (%)	
Male	24 (54.5)
Female	20 (45.5)
BMI (mean, SD)	28.3 ± 3.6
Patella type (Wiberg) (n, %)	
I	4 (9.1)
II	22 (50.0)
III	18 (40.9)
Femorotibial angle (n, %)	
Varus	35 (79.5)
Valgus	9 (20.5)
Degrees (mean, SD)	4.9 ± 1.7
Caton-Deschamps index (mean, SD)	1.1 ± 0.2
Preoperative range of motion (mean, SD) (°)	
Flexion	106.7 ± 6.8
Extension	8.9 ± 3.6
Preoperative patellar thickness (mean, SD) (mm)	22.6 ± 3.9
Preoperative VAS score (mean, SD)	7.8 ± 0.9
Preoperative KSS (mean, SD)	
Clinical	52.6 ± 6.1
Functional	49.5 ± 5.8
AKP n (%)	31 (70.4)

SD = standard deviation; BMI = body mass index; VAS = visual analog scale; KSS = *Knee Society Score*; AKP = anterior knee pain.

Clinical-Functional Analysis

Anterior knee pain was recorded if the patient reported pain in the patellar region when rising from a chair, climbing or descending stairs, or with flexion >90° while standing prior to surgery.[8] In addition, the visual analog scale (VAS) for pain[9] and the *Knee Society Score* (KSS) were used.[10] Range of motion was assessed with a goniometer.

All data were obtained in a face-to-face interview conducted by an attending surgeon or a fellow trained in knee reconstruction. Preoperative values were compared with those at the last follow-up.

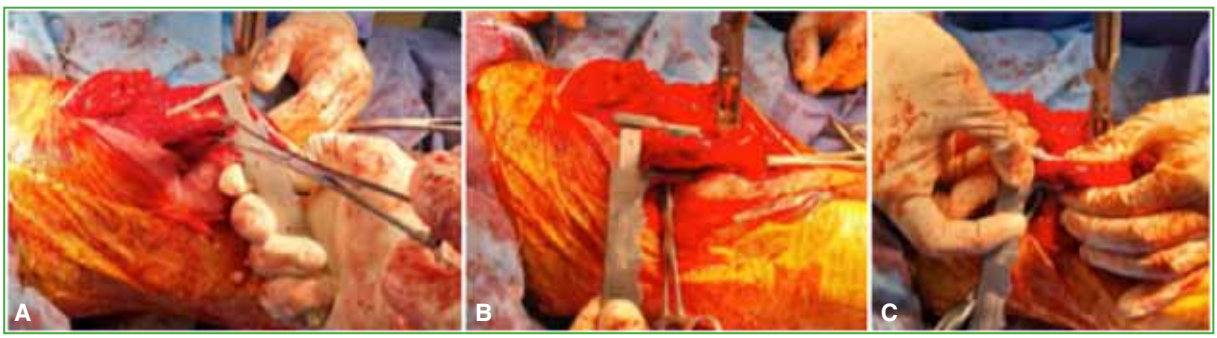

Figure. **A.** Measurement of the patella before osteotomy. **B.** Measurement of the bony remnant. **C.** Measurement with a polyethylene trial button.

Radiographic Analysis

Anteroposterior, lateral, and 30° axial projections were obtained for radiographic assessment.

Alignment was categorized according to the angle formed between the anatomical axes of the femur and tibia: neutral from 5° to 7° of valgus, varus <5° of valgus, and valgus >7° of valgus.[11]

Patellar height was determined using the Caton-Deschamps method.[12]

Complications

Any perioperative patellar complication, such as necrosis, fracture, or maltracking, was documented. We also recorded the revision rate for any cause.

Statistical Analysis

Categorical variables are described as frequency and percentage, and continuous variables as mean and standard deviation or median and interquartile range, depending on distribution. Qualitative variables were compared using the $\chi 2$ test (or Fisher's exact test) or ANOVA. The Student's t-test or Mann–Whitney test was used to compare quantitative data. Pre- and postoperative variables were correlated with Pearson's or Spearman's coefficient, according to distribution.

Statistical significance was set at $p < 0.05$. All data were entered into an Excel spreadsheet (Redmond, USA).

GraphPad Prism 10.0 (La Jolla, CA, USA) was used for analysis.

RESULTS

Clinical-Functional Outcome

There was a statistically significant improvement in range of motion after arthroplasty (flexion: 106.7 ± 6.8° vs. 114.7 ± 3.1°; $p < 0.01$; extension: 8.9 ± 3.6° vs. 3.4 ± 1.0°; $p < 0.01$), and there were no significant differences in patellar height (preoperative 1.1 ± 0.2 vs. postoperative 1.0 ± 0.1; $p = 0.77$).

Comparing preoperative scores (VAS, anterior knee pain, and KSS), a statistically significant improvement was observed on each scale after surgery (Table 2).

Radiological Outcomes

The femorotibial angle changed from 4.9 ± 1.7° (varus) to 2.3 ± 1.2° (valgus).

There were no statistically significant differences between pre- and postoperative patellar thickness (22.6 ± 2.9 mm vs. 22.0 ± 1.5 mm; $p = 0.09$).

Furthermore, no significant differences were found when analyzing patellar thickness by sex (Table 3).

Overall, 15.9% (n = 7) of patients had the same postoperative thickness as before surgery. Differences of 1, 2, and 3 mm were observed in 45.5% (n = 20), 29.5% (n = 13), and 9.1% (n = 4) of patients, respectively, after surgery.

No statistical association was detected in postoperative KSS values (clinical and functional) among patients with differences of 0, 1, 2, or 3 mm after surgery ($p = 0.10$).

Table 2. Pre- and postoperative clinical scores.

Variable	Preoperative	Postoperative	p
VAS (mean, SD)	7.8 ± 0.9	1.7 ± 0.6	<0.01
AKP (n, %)	31 (70.4)	10 (22.7)	<0.01
KSS (mean, SD)			
Clinical	52.6 ± 6.1	83.2 ± 4.7	<0.01
Functional	49.5 ± 5.8	80.8 ± 3.3	<0.01

SD = standard deviation; VAS = visual analog scale for pain; AKP = anterior knee pain; KSS = Knee Society Score.

Table 3. Comparison of patellar thickness according to gender.

Variable	Male	Female	p
Preoperative patellar thickness (mean, SD) (mm)	22.7 ± 2.1	20.9 ± 1.7	0.49
Bone remnant thickness (mean, SD) (mm)	13.9 ± 1.6	14.0 ± 1.5	0.91
Postoperative patellar thickness (mean, SD) (mm)	21.9 ± 1.7	22.0 ± 1.4	0.89

SD = standard deviation.

Complications

No fractures, necrosis, or patellar maltracking were recorded. No revisions had occurred by the time the study was closed.

DISCUSSION

The most important finding of our study was that there were no significant differences in clinical-functional outcomes, complication rates, or revision rates in TKA patients in whom native patellar thickness was not restored.

There was a significant improvement in range of motion after TKA, with flexion increasing from 106.7 ± 6.8° to 114.7 ± 3.1° ($p < 0.01$) and extension improving from 8.9 ± 3.6° to 3.4 ± 1.0° ($p < 0.01$). These findings are consistent with those of Bonifacio et al., who observed an increase in maximum flexion from 99° to 113° in patients undergoing TKA with the same prosthesis design.[13] Regarding VAS and KSS scores, significant improvements similar to those reported by Bartolomeo et al. were also achieved in a study evaluating 62 patients with 63 TKAs using posterior-stabilized prostheses, with values ranging between 88.5 and 86.[14]

Mixed results have been reported regarding the impact of patellar thickness on postoperative outcomes. Some studies suggest that maintaining adequate thickness (typically 24–26 mm for men and 22–24 mm for women)[15] is essential to prevent complications, such as fractures or malalignment,[16,17] whereas others found no direct correlation between patellar thickness and knee biomechanical function after TKA.[18]

In our study, there were no statistically significant differences in pre- vs. postoperative patellar thickness (22.6 ± 2.9 mm vs. 22.0 ± 1.5 mm; $p = 0.09$), including sex-stratified analyses. These results suggest that restoration of patellar thickness was consistent in both sexes.

Excessive thickness at the patellofemoral joint ("overstuffing") has been reported to negatively impact clinical outcomes after TKA.[19,20] An increase of 2 mm or more may significantly raise patellofemoral shear force during knee flexion.[21] With a 1-mm increase, the patella may lateralize, and for every 2-mm increase in total thickness, up to 3° of flexion may be lost.[22]

Although the mean follow-up in our study is relatively short to evaluate the effect of thickness on loosening, there were no significant differences in KSS clinical and functional subscales among patients with 0-, 1-, 2-, or 3-mm differences. We believe that, to achieve satisfactory results in patellofemoral management, ensuring proper tracking is essential, which requires careful attention to soft-tissue releases and component orientation (especially rotation), while respecting joint-line height.

Our study has limitations. It is a retrospective series with a small sample size, few complications, and short follow-up. Nevertheless, we consider it a starting point for future research, since in Argentina and the broader Latin American population, information on patellofemoral management and patellar thickness is scarce.

CONCLUSION

In our study, postoperative patellar thickness did not have a significant impact on clinical-functional scores, complication rates, or revision after primary TKA.

Conflicts of interest: The authors declare no conflicts of interest.

M. A. Oláran ORCID ID: https://orcid.org/0009-0002-8981-4483
G. Garabano ORCID ID: https://orcid.org/0000-0001-5936-0607
C. Á. Pesciallo ORCID ID: https://orcid.org/0000-0002-4461-8465

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