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Pseudo-patella baja after total knee arthroplasty: Radiological evaluation and clinical repercussion

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ABSTRACT

Background: Anterior knee pain is an important complication after total knee arthroplasty (TKA). One possible contributor is the elevation of the joint line, known as pseudo-patella baja (PPB). Limited research has been conducted regarding this condition impacting TKA management. This study aims to evaluate the incidence, identify possible related factors and assess PPB clinical repercussions.

Methods: A total of 813 consecutive TKAs were retrospectively reviewed. Patients were submitted to the same surgical procedure and information regarding TKA characteristics was collected. Lateral postoperative knee radiographs were analyzed using the modified Insall–Salvati Ratio and the Blackburne–Peel Index. A clinical evaluation was conducted on 112 knees where the Oxford Knee and Kujala Scores were applied. Range of motion was evaluated, and knee pain was assessed using the numeric pain rating scale, in addition to analgesic consumption.

Results: A cohort of 612 knees was analyzed, of which 64 knees developed PPB (10.5% incidence). Statistically significant differences were found for advance components sizes (femoral $P = 0.026$ and tibial $P < 0.001$), polyethylene thickness ($P < 0.001$) and patients' height ($P = 0.022$) with smaller implant sizes, greater insert thicknesses and lower height showing an association with PPB. The PPB group had a significantly lower median Kujala score ($P = 0.011$), higher frequency of flexion contracture and of anterior knee pain ($P = 0.039$).

Conclusion: PPB has a clinical relevance that should not be overlooked. Its prevention through the recreation of the natural position of the joint line and correct choice of implant sizes and polyethylene thickness is of major importance and should always be considered.

1. Introduction

Ever since the first total knee arthroplasty (TKA) was performed in the early 1970 s, there has been a constant increase in the frequency of this procedure. According to the latest annual report, there were 2.5 million TKAs performed in Europe alone [1]. Despite being a cost-effective orthopedic surgery for patients who suffer from end-stage knee osteoarthritis,

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anterior knee pain may be an unwanted adverse effect caused by biomechanical changes in the joint [2] and it is reported to occur in 26% of patients submitted to TKA without patellar resurfacing [3].

The source of this type of pain remains uncertain, although there has been a reference to patellar height as one of the possible implied factors. Acquired patella baja (PB) is a globally recognized complication after this procedure, with a reported incidence between 34% [4] and 37% [5]. PB is characterized by patellar tendon shortening and scarring during surgery leading to a distal displacement of the patella and it has been described as one of the leading causes of anterior knee pain after TKA [4–6]. Even though its causation is likely to be multifactorial, a factor that is associated with patellar tendon scarring is the quantity of fat pad resection, because radical resection to increase the exposure of the patella during surgery may lead to ischemia of the patellar tendon and secondary shrinking [7]. This pathology is also reported to be linked to the joint mechanics' alterations, extensor apparatus' weakness, decreased range of motion (ROM), and reduced functional outcome following TKA [8].

Conversely, a similar condition characterized by an abnormal relationship between the patella and the knee joint can arise. In pseudo-patella baja (PPB), the distance between the patella and the femoral trochlea is decreased due to a raising of the joint line instead of tendon shortening. Such elevation may be due to femoral over-resection, tibial undercut, or excessive soft tissue release during TKA that demands a large polyethylene insert to stabilize the knee [9].

Few studies have been conducted regarding PPB following TKA and its clinical relevance [5,9–14]. Hence, the frequency and outcomes of this postoperative condition are not fully understood. Our study aims to evaluate the incidence, identify possible contributors, and assess the clinical repercussion of PPB in patients previously submitted to TKA.

2. Material and methods

This observational study was divided into two different phases. The first part entailed a retrospective analysis including an evaluation and collection of information regarding general patient data, characteristics of the implants used during surgery, and post-TKA radiographs; the second phase consisted of collecting anthropometric information from the patients, as well as the application and analysis of functional scores and pain assessment after surgery. The knee was the overall unit of analysis.

2.1. General patient characteristics – First phase

In this single-center study, we selected 813 consecutive primary TKAs at a tertiary hospital between January 2016 and March 2019. Inclusion criteria were (1) age over 18 years, (2) patients whose indication for surgery was primary osteoarthritis, and (3) patients with postoperative lateral radiographs at 30° flexion within 7 days after TKA.

Demographic data were collected regarding age and sex, besides TKA laterality and TKA implant components characteristics.

2.2. Surgery procedure – First phase

All patients were submitted to a standard TKA protocol. With the patients in dorsal decubitus and under locoregional anesthesia, a medial parapatellar approach was used. A standard system of intramedullary guides and anterior referencing was used. All patients received an anterior, stabilized implant with a fixed tibial tray and the patella was not resurfaced in any patient. An anterior referencing was used to size the femoral component. The implants used were either Advance® Knee System (Wright Medical, USA) or Vanguard® Anterior Stabilized Knee (Biomet, USA).

The surgical intervention was followed by a 48-h course of intravenous antibiotics and deep vein thrombosis prophylaxis for a period of 4 weeks. All patients, when medically fit, were discharged to their own homes.

2.3. Radiological evaluation – First phase

All patients included had postoperative knee profile radiographs at 30° of flexion performed at our institution with a standardized radiological protocol, increasing reproducibility. The radiological evaluation was blindly performed by one researcher and included two widely used ratios: (1) modified Insall–Salvati Ratio (mISR) and (2) Blackburne–Peel Index (BPI).

In the mISR "the distance between the inferior articular surface of the patella and the patellar tendon insertion is divided by the length of the articular surface" (Figure 1(A)) [15]. The usage of this ratio allowed us to detect and exclude PB (mISR < 1.2) and patella alta (mISR $\geq$ 2.0).

Because mISR is unable to identify PPB because the joint line's position is not considered, the BPI was evaluated in patients with normal patellar height. By dividing the distance between the inferior border of the articular surface of the patella and the tibiofemoral joint line by the length of the articular surface [16], we were able to identify and stratify patients' knees into two groups: PPB group (defined as BPI < 0.54) and non-PPB group (BPI $\geq$ 0.54) (Figure 1(B)). The joint line was defined as a line parallel to the tibial plateau and tangent to the femoral component.

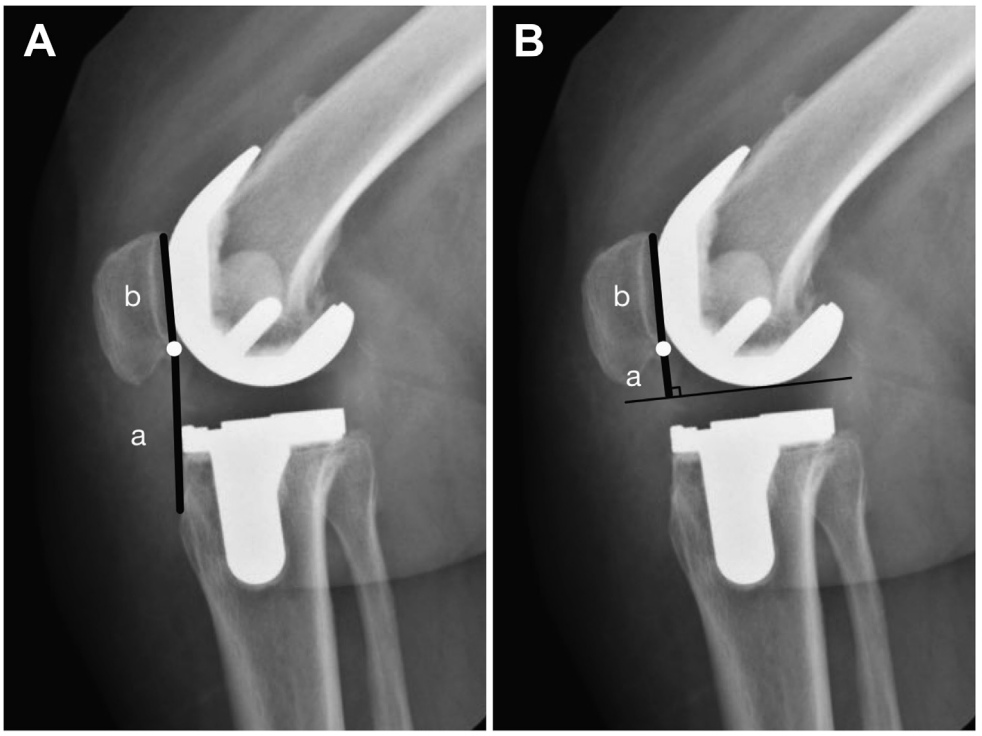

Figure 1. (A) The modified Insall–Salvati Ratio is calculated as a/b. (B) The Blackburne–Peel Index is calculated as a/b.

2.4. Clinical assessment – Second phase

Given the current COVID-19 pandemic, clinical evaluation was carried out via a telephone call. We contacted all patients with PPB, and an equivalent group of non-PPB knees was also evaluated. We performed a sample size calculation to estimate the number of patients' knees required to obtain a clinically relevant difference regarding the functional evaluation. The sample size calculation was powered towards the Kujala score, considering a minimal clinically relevant difference of 9.5 as reported by Negahban et al. [17]. For such purpose and to have a similar and comparable number of knees in the non-PPB group, we used a computer to generate a random allocation list of numbers and shuffle patients' IDs based on this random sequence and consecutively contacted these patients with no constraints.

The functional evaluation included the Oxford Knee Score [18] and the Kujala Score [19], joint-specific questionnaires where lower scores are related to worse knee function and knee pain. ROM was also evaluated, with patients reporting either full knee extension or extension contracture and at least 90° of knee flexion or flexion contracture.

Anterior knee pain was assessed using the Numeric Pain Rating Scale (NPRS), varying from 0 to 10 [20] and the need for analgesics was also evaluated. The NPRS was further stratified into 'no pain' (0), 'mild pain' (1–4), 'moderate pain' (5–7), and 'severe pain' (8–10).

Informed consent was obtained from all participants.

2.5. Statistical analysis

Baseline clinical, demographic, and prosthesis characteristics were compared between patients with and without PPB using Pearson's Chi-squared test, Fisher's exact test and Wilcoxon rank-sum test, as appropriate. The level of significance for all hypothesis tests (*P*-value) was set at 0.05. The normality of the distribution of continuous variables was evaluated by visually inspecting the quantile–quantile (QQ) plots. Continuous variables are presented as median and 25–75% quartiles (interquartile range (IQR)). Categorical variables are presented as absolute (*n*) and relative (%) frequencies. Statistical analysis was performed with R (R Core Team 2017. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL: https//www.R-project.org).

2.6. Ethics

Approval from the local Ethics Committee was obtained.

3. Results

From the 813 TKA procedures performed during this time interval, we included 612 knees for analysis in our study, as described in the flow diagram (Figure 2); 294 (48%) were left knees while 318 (52%) were right knees.

In the first phase of the study, there were 573 patients, given that 39 patients had surgery on both knees during this time interval. Regarding the age and sex of the patients, 427 (75%) were women while 146 (25%) were men, and the median age at the time of the study was 71 years (IQR 65, 77).

The radiological evaluation was performed in every patient, with 63 of these presenting PPB criteria following TKA. Of the PPB group, 10 patients were men (16%) while 53 were women (84%), with a median age of 72 years (IQR 66, 72). Because one patient from the PPB group was submitted to bilateral surgery, a total of 64 knees was included in this group. This resulted in a 10.5% incidence of PPB in patients who underwent TKA. However, no significant differences were found regarding age and sex of patients with or without PPB (P = 0.9 and P = 0.13, respectively).

Statistically significant differences in the type of implant chosen, the size of the two components of the Advance Knee System implant, and the use of different polyethylene thickness were found and are reported in Table 1. However, no significant association between PPB and the size of the Vanguard implant was found.

For the second phase of this study, the clinical evaluation, and in order to detect a clinically relevant difference between knees with and without PPB, established at 9.5 points [17], we performed a power sample calculation. At least 104 patients' knees (52 for each group) provide 80% power, at a 0.05 alfa level, to detect a 9.5 change difference between knees with and without PPB. Therefore, we managed to established contact with 55 patients with PPB, representing 56 knees analyzed. In addition, through the randomization process previously explained, we consecutively contacted non-PPB patients until 56 knees were also assessed in this group. Therefore, 47 patients were recruited, making a total of 112 knees analyzed in this phase.

As for anthropometric parameters, the median height of patients with PPB was 157 cm (IQR 153, 160) vs. 160 cm (IQR 155, 165) from the non-PPB group, reaching statistically significant differences (P = 0.022). However, no differences were found in weight (with a median of 75 kg in the PPB group vs. 76 kg in the non-PPB group, P = 0.2) or body mass index (median of 31.1 kg/m^2 vs. 29.9 kg/m^2, P = 0.7).

Regarding the postoperative ROM, although no relation was found between extension deficit and PPB (5% vs. 7%, P > 0.9), a significant association was determined between PPB and flexion contracture, as 25% of patients with PPB reported this limitation in comparison with 7% of the non-PPB group (P = 0.041).

The median Kujala Score was 59 and 70 for the PPB and non-PPB subgroups (P = 0.011), respectively. Nonetheless, the Oxford Knee Score was similar in both groups, despite being lower in the PPB group. A statistically significant difference was found regarding pain perceived by the patients as reported by the NPRS (P = 0.039), but the use of analgesics was not found to be significantly relevant (P = 0.14), with the complete results depicted in Table 2.

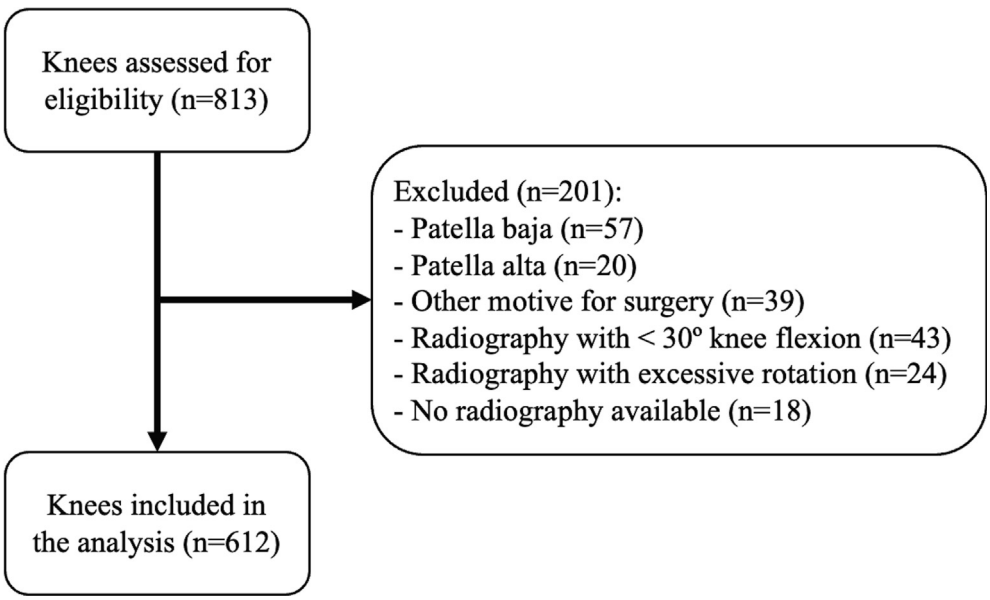

Figure 2. Flow diagram of included knees.

Table 1
Total knee arthroplasty characteristics in patients from pseudo-patella baja (PPB) group and non-PPB group.

Characteristic	Overall, n = 612 [a]	PPB, n = 64 [a]	Non-PPB, n = 548 [a]	P [b]
Prosthesis				0.038
Advance	520 (85%)	60 (94%)	460 (84%)	
Vanguard	92 (15%)	4 (6.2%)	88 (16%)	
Polyethylene thickness (mm)				<0.001
10	435 (71%)	34 (53%)	401 (73%)	
12	127 (21%)	21 (33%)	106 (19%)	
14	38 (6.2%)	3 (4.7%)	35 (6.4%)	
16	1 (0.2%)	0 (0%)	1 (0.2%)	
17	11 (1.8%)	6 (9.4%)	5 (0.9%)	
Advance femoral component (mm)				0.026
52	58 (11%)	14 (23%)	44 (9.6%)	
57	281 (54%)	30 (50%)	251 (55%)	
62	136 (26%)	14 (23%)	122 (27%)	
66	45 (8.7%)	2 (3.3%)	43 (9.3%)	
Advance tibial component (mm)				<0.001
60	18 (3.5%)	8 (13%)	10 (2.2%)	
65	187 (36%)	21 (35%)	166 (36%)	
70	212 (41%)	26 (43%)	186 (40%)	
75	87 (17%)	3 (5.0%)	84 (18%)	
80	16 (3.1%)	2 (3.3%)	14 (3.0%)	
Vanguard femoral component (mm)				0.5
55	11 (12%)	0 (0%)	11 (12%)	
57.5	11 (12%)	2 (50%)	9 (10%)	
60	21 (23%)	0 (0%)	21 (24%)	
62.5	19 (21%)	1 (25%)	18 (20%)	
65	18 (20%)	1 (25%)	17 (19%)	
67.5	4 (4.3%)	0 (0%)	4 (4.5%)	
70	4 (4.3%)	0 (0%)	4 (4.5%)	
75	4 (4.3%)	0 (0%)	4 (4.5%)	
Vanguard tibial component (mm)				0.9
63	11 (12%)	11 (12%)	0 (0%)	
65	2 (2.2%)	2 (2.3%)	0 (0%)	
67	30 (33%)	27 (31%)	3 (75%)	
68	1 (1.1%)	1 (1.1%)	0 (0%)	
70	2 (2.2%)	2 (2.3%)	0 (0%)	
71	26 (28%)	25 (28%)	1 (25%)	
72	1 (1.1%)	1 (1.1%)	0 (0%)	
75	9 (9.8%)	9 (10%)	0 (0%)	
79	7 (7.6%)	7 (8.0%)	0 (0%)	
83	3 (3.3%)	3 (3.4%)	0 (0%)	

[a] Statistics presented: n (%).
[b] Statistical tests performed: Pearson's Chi-squared test; Fisher's Exact Test for Count Data with simulated P-value (based on 2000 replicates); Wilcoxon rank-sum test; Fisher's exact test.

Table 2
Comparison between pseudo-patella baja (PPB) group and non-PPB group regarding clinical evaluation results.

Characteristic	Overall, n = 112 [a]	PPB, n = 56 [a]	Non-PPB, n = 56 [a]	P [b]
Kujala Score	67 (52, 79)	59 (46, 74)	70 (61, 81)	0.011
Oxford Knee Score	34 (25, 40)	32 (20, 39)	35 (28, 40)	0.073
Numeric Pain Rating Scale				0.039
No pain	15 (13%)	6 (11%)	9 (16%)	
Mild pain	45 (40%)	17 (30%)	28 (50%)	
Moderate pain	36 (32%)	21 (38%)	15 (27%)	
Severe pain	16 (14%)	12 (21%)	4 (7.1%)	
Use of analgesics				0.14
None	56 (50%)	25 (45%)	31 (55%)	
Sporadic	25 (22%)	15 (27%)	10 (18%)	
Weekly	15 (13%)	5 (8.9%)	10 (18%)	
Daily	16 (14%)	11 (20%)	5 (8.9%)	

[a] Statistics presented: n (%); median (interquartile range).
[b] Statistical tests performed: Pearson's Chi-squared test; Fisher's Exact Test for Count Data with simulated P-value (based on 2000 replicates); Wilcoxon rank-sum test; Fisher's exact test.

4. Discussion

In our study, the PPB incidence (10.5%) in the 612 consecutive TKAs is comparable with the PPB incidence in other studies, ranging from 9% to 26.7% [10–12,21]. However, these numbers relate to samples from 60 to 354 knees, much lower than the 628 in the present study. Furthermore, unlike most studies, we decided to use the mISR that considers the length of the patella joint expanse instead of the maximum diagonal length of the patella as in the original Insall–Salvati Ratio [22] which is more likely to be influenced by the shape of the patella. The mISR index does not consider the length of the inferior pole, and its use reduces the rate of false-positive cases [21]. Besides, its denominator is the same measure used in the BPI, which may minimize further evaluation errors. The combination of the two indices was fundamental, and the choice of the BPI as a PPB identifier was made since this index is reported to be the most reproducible and consistent measurement for these cases, besides having a good interobserver agreement [23].

One of the strengths of our study was that, to the best of our knowledge, it was the first to investigate the relationship between PPB and implant sizes. Indeed, several reports in the literature mention that PPB is dependent of the thickness of the polyethylene insert used [9,11,14], and our study agrees with this finding, having reported an association for greater thicknesses of polyethylene inserts and PPB. However, no other study has evaluated the sizes of the femoral and tibial components. The results we have reached in this matter demonstrate that, for our population, there is an association between choosing smaller femoral Advance components and the development of PPB. Regarding the tibial component, the differences we report may be a consequence of the femoral size choice since, for a given femoral component, one can only choose between the size above and the size below of the tibial implant. Besides, the statistically significant differences found concerning patients' height may be linked with the choice of the size of the components. Shorter people may lead, per se, to the choice of smaller prostheses. Thus, future investigations should be performed in order to establish the predominant role of each of these variables and to understand whether patient height is an independent risk factor for PPB developing.

We also found an association between PPB and the type of prosthesis used, but no statistically significant differences were reported between the various sizes of Biomet's Vanguard implants. However, such findings should be interpreted with caution, given the lower frequency of TKAs where this type of implant was used, accounting for only 15% of the whole 612 procedures.

In terms of functional scores, other reports in the literature have detected a non-statistically significant decrease in functional outcomes assessed associated with PPB [10–13]. The current study further supports the burden of evidence, showing a decrease in the Oxford Knee Score results, although not statistically significant ($P = 0.073$). This score is explicitly intended for use with TKA alone, being simpler and quicker to process in comparison with scores used by other authors such as the Knee System Score and the Western Ontario and McMaster Universities Arthritis Index (WOMAC). Besides, a cross-cultural adaptation and validation of the Portuguese version of the Oxford Knee Score was used to assess this outcome in our population correctly [24].

Another advantage of this study was using the Kujala Score since it is considered a reliable and valid instrument for measuring anterior knee pain after TKA [25]. Metsna et al. [26] established a score of 74.6 in its pain-free group as a standard value in a symptomless population after TKA, since a replaced knee cannot be expected to function in the same way as an original undamaged joint. Knees with anterior knee pain originating from the patellofemoral joint after this procedure were associated with a Kujala score of 61% of the standard value. The current study agrees with these results, showing that PPB knees are more likely to have anterior knee pain than non-PPB knees. Despite the statistical significance, the difference in this score between the two groups was 11 points, slightly higher than the minimal clinically important difference established at 9.5 points [17]. The Kujala Score proved to be a very useful questionnaire for evaluating this outcome after TKA and should be used widely as its measurement. Likewise, we used a valid translation of the questionary to ensure the maintenance of the content validity of the original version [27]. Thus, the fact that PPB negatively influences the Kujala Score without significant differences in the Oxford Knee Score may indicate that this condition appears to be associated with more anterior knee pain rather than general functional limitation.

In addition to these findings and coinciding with the previous association, our study also found a correlation between the NPRS and PPB, where PPB knees are associated with more intensity in pain than non-PPB knees. This association is also mirrored in the use of analgesics. Although no statistically significant differences were found in their use frequency, we found a higher percentage of cases that required daily use of analgesia (20% in the PPB group vs. 8.9% in the non-PPB group). However, we present a small number of clinically assessed knees, making it difficult to evaluate this outcome correctly. Further studies should be performed in order to understand better if PPB is associated with more analgesic consumption and decrease in quality of life than non-PPB knees after TKA in the long term.

To prevent PPB after TKA, intra-operative awareness of patellar tracking, including the reconstitution of the natural joint line, is of major importance, in addition to a consistent early and prolonged rehabilitation with appropriate analgesia [11]. Thus, careful planning in the femoral cut is recommended to avoid unnecessary usage of smaller implant sizes and higher thickness of polyethylene, especially in shorter people, with consequent elevation of the joint line, and to maintain ideal patellofemoral biomechanics.

The present study has some limitations. Firstly, the small number of patients clinically evaluated may limit the interpretation of the results obtained in the second phase, even though we believe it is a valid sample for comparison. Secondly, due to the COVID-19 pandemic, the fact that we evaluated these patients via a telephone call rather than in person may also

influence our findings. However, nowadays, both teleconsultation and the application of scores over the phone are widely used and allow us to have real feedback on the patient's status. Thirdly, the fact that this was a retrospective study is in itself a limitation. Because preoperative flexion contracture is a common reason for elevating the joint line as it frequently needs additional distal femur resection to get the knee into full extension, its analysis would be very important. Therefore, future studies should address this preoperative condition, as well as other possible comorbidities. Finally, the radiological evaluation has some inherent limitations. Although all radiographs were performed using a standardized protocol, measurement errors by differences in the rotational position are intrinsic, and the exact reference landmarks can also be difficult to determine after TKA. Adding to this, only one observer, who was not involved in the surgeries, performed the measurements. However, we strongly agree with the fact that such a design option does not affect the validity of our results as this is the situation we encounter in our daily routine and it gives us a realistic view of the measurement we experience in clinical practice. Finally, another limitation is the retrospective nature of the study.

Future investigations should address an in-depth study of the joint line's elevation between pre- and postoperative periods, as this elevation appears to underlie the symptomatology. Furthermore, prospective studies where scores can be evaluated before and after the procedure and concomitant comorbidities in order to have a more reliable evaluation should also be considered.

5. Conclusion

Despite its incidence, PPB is a clinically relevant condition because it is associated with increased anterior knee pain, decreased ROM and functional scores, and possibly increased analgesic consumption. Thus, we believe that the recreation of the natural position of the joint line and the correct choice of implant sizes and polyethylene thickness during TKA are of major importance and should always be considered when performing this procedure.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Lübbeke A, Silman AJ, Barea C, Prieto-Alhambra D, Carr AJ. Mapping existing hip and knee replacement registries in Europe. Health Policy 2018;122(5):548–57. doi: https://doi.org/10.1016/j.healthpol.2018.03.010.
[2] Hawker G, Wright J, Coyte P, Paul J, Dittus R, Croxford R, et al. Health-related quality of life after knee replacement. Results of the Knee Replacement Patient Outcomes Research Team Study. JBJS 1998;80(2):163–73. doi: https://doi.org/10.2106/00004623-199802000-00003.
[3] He J-Y, Jiang L-S, Dai L-Y. Is patellar resurfacing superior than nonresurfacing in total knee arthroplasty? A meta-analysis of randomized trials Knee 2011;18(3):137–44. doi: https://doi.org/10.1016/j.knee.2010.04.004.
[4] Weale AE, Murray DW, Newman JH, Ackroyd CE. The length of the patellar tendon after unicompartmental and total knee replacement. J Bone Joint Surg Br 1999;81(5):790–5. doi: https://doi.org/10.1302/0301-620x.81b5.9590.
[5] Floren M, Davis J, Peterson MG, Laskin RS. A mini-midvastus capsular approach with patellar displacement decreases the prevalence of patella baja. J Arthroplasty 2007;22(6 Suppl 2):51–7. doi: https://doi.org/10.1016/j.arth.2007.05.008.
[6] Chonko DJ, Lombardi Jr AV, Berend KR. Patella baja and total knee arthroplasty (TKA): etiology, diagnosis, and management. Surg Technol Int 2004;12:231–8.
[7] Gallagher J, Tierney P, Murray P, O'Brien M. The infrapatellar fat pad: anatomy and clinical correlations. Knee Surg Sports Traumatol Arthrosc 2005;13(4):268–72. doi: https://doi.org/10.1007/s00167-004-0592-7.
[8] Yang JS, Fulkerson JP, Obopilwe E, Voss A, Divenere J, Mazzocca AD, et al. Patellofemoral contact pressures after patellar distalization: A biomechanical study. Arthroscopy 2017;33(11):2038–44. doi: https://doi.org/10.1016/j.arthro.2017.06.043.
[9] Grelsamer RP. Patella baja after knee arthroplasty surgery. Is it really patella baja? Semin Arthroplasty 2009;20(3):183–6. doi: https://doi.org/10.1053/j.sart.2009.09.007.
[10] Bugelli G, Ascione F, Cazzella N, Franceschetti E, Franceschi F, Dell'Osso G, et al. Pseudo-patella baja: A minor yet frequent complication of total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc 2018;26(6):1831–7. doi: https://doi.org/10.1007/s00167-017-4828-8.
[11] Kazemi SM, Daftari Besheli L, Eajazi A, Miniator Sajadi MR, Okhovatpoor MA, Farhang Zanganeh R, et al. Pseudo-patella baja after total knee arthroplasty. Med Sci Monit 2011;17(5):CR292–6. doi: https://doi.org/10.12659/msm.881770.
[12] Aguirre-Pastor A, Ortolá DJ, Lizaur-Utrilla A, Rosa MA, Lopez-Prats FA. Is pseudo-patella baja really a serious complication of total knee arthroplasty? J Arthroplasty 2020;35(2):557–62. doi: https://doi.org/10.1016/j.arth.2019.09.031.
[13] Behrend H, Graulich T, Gerlach R, Spross C, Ladurner A. Blackburne-Peel ratio predicts patients' outcomes after total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc 2019;27(5):1562–9. doi: https://doi.org/10.1007/s00167-018-5016-1.
[14] Thornton-Bott P, Unitt L, Johnstone D, Sambatakakis A. Pseudo-patella baja following soft tissue balancing in total knee arthroplasty. Orthopaedic Proceedings 2012;94-B(SUPP_II):119. doi: https://doi.org/10.1302/1358-992X.94BSUPP_II.BOA2005-119.
[15] Grelsamer RP, Meadows S. The modified Insall–Salvati ratio for assessment of patellar height. Clin Orthop Relat Res 992(282):170–6.
[16] Blackburne JS, Peel TE. A new method of measuring patellar height. J Bone Joint Surg Br 1977;59(2):241–2. doi: https://doi.org/10.1302/0301-620X.59B2.873986.
[17] Negahban H, Mostafaee N, Sohani SM, Hessam M, Tabesh H, Montazeri A. Responsiveness and minimally important differences for selected Persian-version of outcome measures used in patients with patellofemoral pain syndrome. Disabil Rehabil 2015;37(14):1285–90. doi: https://doi.org/10.3109/09638288.2014.962107.

[18] Dawson J, Fitzpatrick R, Murray D, Carr A. Questionnaire on the perceptions of patients about total knee replacement. J Bone Joint Surg Br 1998;80 (1):63–9. doi: https://doi.org/10.1302/0301-620x.80b1.7859.
[19] Kujala UM, Jaakkola LH, Koskinen SK, Taimela S, Hurme M, Nelimarkka O. Scoring of patellofemoral disorders. Arthroscopy 1993;9(2):159–63. doi: https://doi.org/10.1016/s0749-8063(05)80366-4.
[20] Williamson A, Hoggart B. Pain: a review of three commonly used pain rating scales. J Clin Nurs 2005;14(7):798–804. doi: https://doi.org/10.1111/j.1365-2702.2005.01121.x.
[21] Xu B, Xu WX, Lu D, Sheng HF, Xu XW, Ding WG. Application of different patella height indices in patients undergoing total knee arthroplasty. J Orthop Surg Res 2017;12(1):191. doi: https://doi.org/10.1186/s13018-017-0694-9.
[22] Insall J, Salvati E. Patella position in the normal knee joint. Radiology 1971;101(1):101–4. doi: https://doi.org/10.1148/101.1.101.
[23] Berg EE, Mason SL, Lucas MJ, Patellar height ratios. A comparison of four measurement methods. Am J Sports Med 1996;24(2):218–21. doi: https://doi.org/10.1177/036354659602400218.
[24] Gonçalves RS, Tomás AM, Martins DI. Cross-cultural adaptation and validation of the Portuguese version of the Oxford Knee Score (OKS). Knee 2012;19 (4):344–7. doi: https://doi.org/10.1016/j.knee.2011.04.006.
[25] Kievit AJ, Breugem SJ, Sierevelt IN, Heesterbeek PJ, van de Groes SA, Kremers KC, et al. Dutch translation of the Kujala Anterior Knee Pain Scale and validation in patients after knee arthroplasty. Knee Surg Sports Traumatol Arthrosc 2013;21(11):2647–53. https://doi.org/10.1007/s00167-013-2635-4.
[26] Metsna V, Vorobjov S, Martson A. Prevalence of anterior knee pain among patients following total knee arthroplasty with nonreplaced patella: a retrospective study of 1778 knees. Medicina (Kaunas) 2014;50(2):82–6. doi: https://doi.org/10.1016/j.medici.2014.06.001.
[27] Aquino Victor da Silva, Falcon Sandra Fiumana Martins, Neves Laura Maria Tomazi, Rodrigues Reynaldo Costa, Sendín Francisco Alburquerque. Tradução e adaptação cultural para a língua portuguesa do questionário scoring of patellofemoral disorders: estudo preliminar. Acta Ortop Bras 2011;19(5):273–9. doi: https://doi.org/10.1590/S1413-78522011000500002.