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Original Research

Patellar Resurfacing Is Not a Risk Factor for Postoperative Patella Baja in Total Knee Arthroplasty

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ABSTRACT

Background: Patella baja is a known complication of total knee arthroplasty (TKA). There is a limited understanding of the association between patellar resurfacing and the incidence of patella baja. We aimed to compare rates of patella baja between unresurfaced and resurfaced patellas in patients undergoing TKA.

Methods: A retrospective review of patients who underwent TKA between October 2009 and January 2020 was performed. Patients were included if they had at least one preoperative radiograph and a 1-year follow-up radiograph. Blackburne-Peel index (BPI) and Insall-Salvati ratios (ISRs) were measured on preoperative and 1-year postoperative radiographs and were used to define patella baja vs pseudopatella baja. Statistical analysis was performed using a linear model analysis of variance and the Fisher's exact test.

Results: Three hundred eighteen TKAs were included, with 176 being resurfaced and 142 unresurfaced patellas. Of the resurfaced group, 4% (7/176) had true patella baja, compared to 5.6% (8/142) of the unresurfaced patellas. Of the resurfaced patellas, 8% (14/176) had pseudopatella baja, compared to 7% (10/142) in the unresurfaced group. Patellar resurfacing was not associated with a higher incidence of patella baja ($P = .60$) or pseudopatella baja ($P = .83$). Lower preoperative ISRs ($P = .04$) and BPIs (0.03) were highly predictive of a higher incidence of patella baja post-TKA.

Conclusions: Patellar resurfacing in TKA is not associated with a higher incidence of patella baja in TKA when compared to unresurfaced patellas. Lower preoperative ISRs and BPIs are highly predictive of a higher incidence of postoperative patella baja.

Introduction

Although a seemingly simple sesamoid bone, the patella plays a significant role in the biomechanics of the extensor mechanism of the knee. The patella functions to improve quadriceps efficiency by over 50% by increasing the lever arm of the extensor mechanism [1]. Although total knee arthroplasty (TKA) is an extremely successful and reproducible surgery, complications involving the patella and extensor mechanism continue to be a common cause of revision in TKA [2]. One of these complications is patella baja. "Baja" is Spanish for low; therefore, patella baja is the condition of an abnormally low-lying patella. This condition is thought to be due to traumatic or ischemic injury to the patella tendon during surgery, causing scarring and contraction with resultant inferiorization of the patella. Patellar position plays a significant role in knee joint biomechanics, and abnormalities in patellar alignment or length following TKA will significantly affect overall knee function. A low-lying patella will lead to impingement on the anterior aspect of the tibial insert with flexion, resulting in crepitations, anterior knee pain, decreased range of motion, and lower patient-reported outcomes [3–5].

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Pseudopatella baja is a distinct entity separate from true patella baja with similar adverse patient outcomes [6,7]. Whereas patella baja is due to tendon shortening, pseudopatella baja is a relatively low-lying patella due to a joint line elevation without resultant change in tendon length. Intraoperative technical factors lead to elevation of the joint line and subsequent pseudopatella baja. These factors include over-resection of the distal femoral cut, tibial cut under-resection, inferior placement of the patellar button, or excessive soft tissue release necessitating a thicker polyethylene insert. While pseudopatella baja is attributed to technical factors, various hypotheses attempt to explain the association of true patella baja with TKA. Weale et al. found an association with patella baja in TKA patients who underwent a lateral release [8]. Retention of the infrapatellar fat pad and avoiding patella eversion may also result in decreased ischemic injury to the patellar tendon and a decreased incidence of patella baja, but to date, there is insufficient evidence to draw any associations between patella baja and patella eversion or fat pad resection [9,10].

Management of the patella in TKA continues to be the subject of much debate in the orthopaedic community, specifically with regard to patellar resurfacing. Generally, arthroplasty surgeons fall into one of 3 camps: to always resurface the patella, to selectively resurface the patella, or to never resurface the patella. Currently, there is insufficient consensus to implement a standard of care. Given our current understanding of the etiology of patella baja with regard to tendon ischemia and scar contraction, it is not unreasonable to hypothesize that the increased disturbance of the extensor mechanism that occurs with patellar resurfacing could lead to added trauma to the patellar tendon with a resulting higher incidence of patella baja. To date, no studies have explored the association between patellar resurfacing and the incidence of patella baja. The aim of this study was to compare the incidence of patella baja between unresurfaced patellas and resurfaced patellas in patients undergoing TKA. We hypothesized that due to the increased trauma from patellar resurfacing, we would observe a higher incidence of patella baja in the resurfacing cohort.

Material and methods

A retrospective review was conducted at a single institution of patients who underwent TKA by fellowship-trained arthroplasty surgeons between October 2009 and January 2020. Three surgeons performed patellar resurfacing, while one did not. To detect a meaningful difference between the 2 treatment groups, a total sample size of 115 patients achieves 80% power to detect a difference in effect sizes at a 0.05 significance level. The incidence of patella baja post-TKA within a group is assumed to be 10% as previously outlined in the literature [11]. Patients were included if they had at least one preoperative radiograph and a 1-year follow-up radiograph [12]. All TKA procedures were performed using manual instrumentation with posteriorly stabilized knees. All patellas in the resurfaced group were cemented. Patients with a history of prior knee trauma, revision TKA, tibial osteotomy, patellar tendon injury, or inflammatory arthropathy were excluded. All procedures were done through a medial parapatellar approach. No patients included underwent a tibial tubercle osteotomy, quadriceps snip, or V-Y quadriceps turndown. No patients included had a patellar tendon rupture. In the patella resurfacing group, the extent of Hoffa's fat pad resection was as per surgeon discretion, while in the unresurfaced group, sufficient fat pad was removed as necessary for visualization. Blackburne-Peel index (BPI) and Insall-Salvati ratios (ISRs) were measured on preoperative and 1-year postoperative radiographs [13,14]. These measurements have been previously validated and deemed reproducible [15]. Measurements were performed using a standard PACs system (Q-Reads Clinical Image Viewer v. 5.14.0) [16,17]. Image review was performed by 2 authors independently. The ISR is measured by making a line from the proximal tibial tubercle to the inferior pole of the patella and dividing that distance by the distance from the superior to the inferior pole of the patella. Ratios <0.8 are indicative of patella baja. The BPI is performed by measuring the distance from the inferior articular surface of the patella to a line perpendicular to the joint line and dividing that by the length of the entire articular surface of the patella. (Fig. 1) An ISR of less than 0.8 in addition to a BPI of less than 0.5 was defined as patella baja, whereas a BPI of less than 0.5 alone was defined as pseudopatella baja [16–18]. Statistical analysis was performed using a linear model analysis of variance and Fisher's exact test. Logistic regression was performed controlling for preoperative measurements and patient-specific factors.

Results

In total, 381 knees underwent radiographic evaluation, of which 176 had resurfaced patellas and 142 had unresurfaced patellas. Table 1 shows the demographics of patients included in the study. The total incidence of patella baja in all patients was 4.7% (15/318). The incidence of pseudopatella baja in all patients was 7.5% (24/318).

Of the resurfaced patellas, 4% (7/176 patients) were diagnosed with true patella baja, and 8% (14/176 patients) were diagnosed with pseudopatella baja. This is in comparison to the unresurfaced patella cohort, where 5.6% (8/142 patients) were diagnosed with patella baja, and 7% (10/142 patients) were diagnosed with pseudopatella baja (Fig. 2). There was no association between patella resurfacing in TKA and patella baja ($P = .57$).

Unresurfaced patellas had a lower risk of pseudopatella baja when compared to resurfaced patellas [relative risk (RR) 0.42; $P = .03$]. Regardless of whether the patella was resurfaced or not, patients with lower preoperative ISRs trended toward higher odds of postoperative patella baja [odds ratio (OR) 0.028, $P = .04$]. The same was true with lower preoperative BPIs, as this showed statistically significant higher odds of true patella baja in both resurfaced and unresurfaced patellas (ISR: OR = 0.008, $P = .027$). Table 2 demonstrates the mean change in ISR and BPI post-TKA stratified by resurfaced vs unresurfaced patellas.

Right knees developed patella baja in 3.3% (6/183 patients) of cases, compared to left knees in 5.8% (8/136). There was no statistically significant association between laterality and the incidence of patella baja ($P = .31$) or pseudopatella baja ($P = .08$). Age was not found to be a risk factor for patella baja (OR 0.998, $P = .94$) or pseudopatella baja (OR 1.0, $P = .97$) in our analysis. We found patients with a higher body mass index (BMI) were associated with a lower risk of patella baja (RR 0.87; $P = .02$) and pseudopatella baja (RR 0.91; $P = .01$).

Discussion

Patellar resurfacing in TKA is a subject of ongoing debate among arthroplasty surgeons. Proponents of patella resurfacing cite decreased rates of reoperation in addition to a lower risk of anterior knee pain, whereas none or selective resurfacers will cite decreased complications, bone conservation, and cost savings to guide their decisions on how to manage the patella [19]. To date, no studies have explored the association between patellar resurfacing and the incidence of patella baja. In this radiographic analysis of 318 TKAs, we found that patellar resurfacing is not associated with patella baja after TKA.

Patella tendon shortening is a common complication seen in over one-third of patients after TKA. It is believed that this stems from ischemic or traumatic changes during a TKA, leading to

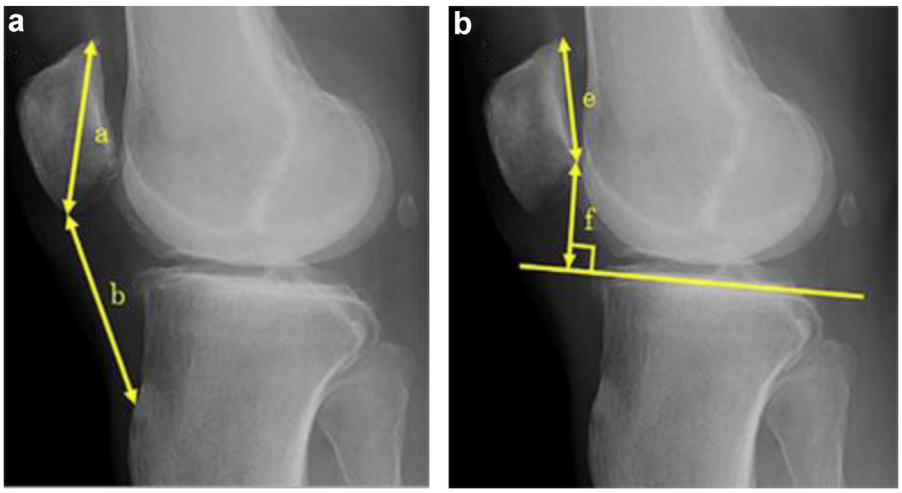

Figure 1. How to measure the Insall-Salvati ratio and the Blackburn-Peel index. (a) Insall-Salvati ratio, measured by a line from the proximal tibial tubercle to the inferior pole of the patella and dividing that distance by the distance from the superior to the inferior pole of the patella (b/a). (b) The Blackburn-Peel index measured the distance from the inferior articular surface of the patella to a line perpendicular to the joint line, dividing that by the length of the entire articular surface of the patella (f/e).

tendon shortening. Nemschak et al. showed that there is decreased vascularity to the patellar tendon with fat pad resection [20]. Both Weale et al. and Davies et al. reported shortening of the patellar tendon >10% of its total length following TKA in 34% and 38% of their patient cohort, respectively [8,21]. Meneghini et al. performed a retrospective review of 1055 primary TKAs. At an average follow-up of 5 years, they found a resultant decrease in tendon length in 50% of patients post-TKA. Of those 50% with a resultant decrease in tendon length, the mean decrease in ISR was 0.21 in the posterior stabilized implant group and 0.15 in the cruciate retaining implant group. In this cohort, the total incidence of patella baja was 9.8% [11]. A separate multicenter retrospective review of 5089 TKAs that underwent patellar resurfacing reported a 5% incidence of patella baja post-TKA [22]. These findings were consistent with our data, as the incidence of patella baja in a mixed resurfaced and non-resurfaced patella cohort following TKA was 4.7% (15/318). This incidence is relatively consistent with previously reported studies [11,22–25].

In evaluating the risk of developing patella baja, perhaps the most important finding in this study is that preoperative ISR and BPI are highly predictive of postoperative outcomes. In our study, the variable most strongly associated with patella baja post-TKA was lower preoperative BPI ($P = .027$) and preoperative ISR ($P = .04$). The same was also true for pseudopatella baja, as lower preoperative BPI was highly associated with postoperative pseudopatella baja ($P < .001$). Song et al. performed a retrospective review on risk factors for developing patella baja or pseudopatella baja after undergoing revision TKA. The most significant risk factor for developing patella baja was the presence of patella baja before surgery (OR 90.2, $P = .001$) [26]. Our finding demonstrates a similar high risk of developing postoperative patella baja with BPI and ISR scores in primary TKA. To our knowledge, no other studies have also identified the association between lower BPI and the incidence of pseudopatella baja post-TKA. This important finding can help aid surgeons in understanding which patients are at an increased risk of developing patella baja or pseudopatella baja after TKA.

Several other patient factors have previously been identified as risk factors for the development of patella baja post-TKA. Francois et al. studied the relationship between BMI and the development of patella baja post-TKA. They evaluated over 5000 TKAs with patellar resurfacing and found a higher incidence of patella baja preoperatively in patients with a higher BMI (>25 kg/m^2). The difference between the 2 groups disappeared postoperatively ($P = .91$) as there was no difference in the prevalence of patella baja between those with a BMI >25 (5%) and those with a BMI <25 (5%). In our cohort of patients, we found that a higher BMI was associated with lower odds of patella baja (OR 0.85) and pseudopatella baja (OR 0.89). This finding could be partly explained by Table 1, where patients with a higher BMI tended to be unresurfaced, which resulted in a lower risk of pseudopatella baja. Nonetheless, taken together with the Francois et al. study, BMI does not appear to

Table 1
Patient demographics.

Patient demographics	Resurfaced patella	Unresurfaced patella	Total	*P* value
Mean age years	69.9 (SD 8.2)	67.9 (SD 10.5)	69.0 (SD 9.2)	.065
Mean BMI	31.0 (SD 6.0)	34.8 (SD 7.6)	32.7 (SD 7.0)	<.001
Laterality				
Right	103	80	183	
Left	74	62	136	
Mean preoperative Insall-Salvati ratio	1.16 (SD 0.19)	1.02 (SD 0.17)	1.10 (SD 0.19)	<.001
Mean preoperative Blackburn-Peel index	0.99 (SD 0.16)	0.83 (SD 0.16)	0.92 (SD 0.18)	<.001

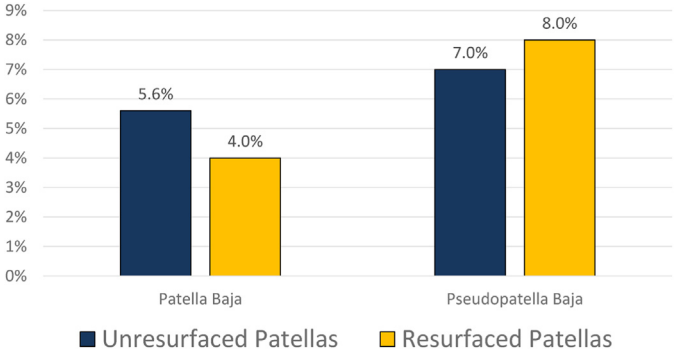

Figure 2. Incsidence of patella baja and pseudopatella baja of resurfaced and unnresurfaced patellas.

Table 2
Mean change in Insall-Salvati ratio and Blackburn-Peele index from preoperative to postoperative stratified by patella resurfacing vs no patellar resurfacing.

	Resurfaced patella	Unresurfaced patella	Total	P value
Mean change in Insall-Salvati ratio	−0.002 (SD 0.11)	0.019 (SD 0.14)	0.01 (SD 0.13)	0.15
Mean change in Blackburn-Peel index	−0.22 (SD 0.21)	0.035 (SD 0.16)	−0.11 (SD 0.23)	<0.001

significantly influence the rate of pseudopatella or patella baja after TKA.

Anagnostakos et al. performed a prospective study to evaluate patient-specific factors that are associated with patellar tendon shortening post-TKA. He evaluated a total of 41 knees at a 1-year follow-up and found statistically significant associations between tendon shortening with male gender ($P = .004$) and left knees ($P = .007$). They found no association between age and tendon shortening [12]. In a study that included over 1000 patients, females were found to be twice as likely as males to develop patella baja post-TKA [11]. In another study of 135 TKAs, females were twice as likely to have a >10% decrease in tendon length as male patients [23]. In our study, we did not find any associations between patella baja with age ($P = .94$), gender ($P = .67$), or laterality ($P = .47$).

There were several limitations to this study. This study, a retrospective review with a cohort comparison, is subject to inherent weaknesses in its study design. Multiple surgeons with varying techniques is an inherent limitation and can affect pseudopatella baja. In addition, a 2-year follow-up is relatively standard in current literature, and thus the follow-up interval of 1 year in this study could be a source of concern. Koshino et al. and Weale et al. demonstrated that the great majority of patellar tendon shortening occurred within 6 months postoperatively, potentially due to ischemia or traumatic injury, with negligible changes in tendon length occurring thereafter [8,25]. Several studies evaluating changes in patellar tendon length were also designed with similar to shorter follow-ups than our study [10,27,28]. Although a great majority of TKA is performed through a standard medial parapatellar approach, this is not always the case, and thus the generalizability of these results with different surgical approaches poses an issue. The amount of fat pad resection also varied between patients and may be an unidentified confounding variable. However, this factor is difficult to control and measure. Finally, ISR and BPI are common radiographic measures, both of which are dependent on knee flexion angle at the time of measurement. Although the institutional protocol for a standard lateral knee radiograph is 30-degree flexion, there was some minor variability in actual flexion angles at the time points at which these radiographs were obtained. This could have resulted in minor differences in ratios that were attributed to differences in flexion angle and not in tendon shortening. Lastly, we did not evaluate clinical outcomes between the cohorts.

Conclusions

The added trauma of patellar resurfacing in TKA is not associated with a higher incidence of patella baja or pseudopatella baja in TKA when compared to unresurfaced patellas. Lower preoperative ISRs and BPIs are highly predictive of a higher incidence of postoperative patella baja.

Conflicts of interest

M. J. Spangehl is a paid consultant for Heraeus, has stock options in Sonoran Biosciences, receives research support from Depuy and Stryker, and is an editorial/governing board member of the Journal of Arthroplasty and Arthroplasty Today. All other authors declare no potential conflicts of interest.

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CRediT authorship contribution statement

Kade S. McQuivey: Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Conceptualization, Data curation, Formal analysis. **Collin Braithwaite:** Validation, Methodology, Investigation, Formal analysis, Data curation, Writing – original draft, Writing – review & editing. **Jordan R. Pollock:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **M. Lane Moore:** Writing – review & editing, Writing – original draft, Validation, Investigation, Formal analysis, Data curation, Conceptualization. **Joseph C. Brinkman:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Jack Haglin:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Roman Austin:** Data curation. **Mark J. Spangehl:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Conceptualization, Data curation, Formal analysis. **Joshua S. Bingham:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Data curation.

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