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Influence of Patella Height on Knee Joint Function after Total Knee Arthroplasty: A Retrospective Study

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Abstract

Purpose: The aim of this study was to explore the correlation between the change of patella height and postoperative functional outcomes, range of motion, and patellar crepitus after total knee arthroplasty.

Materials and methods: Analysis of an observational, retrospective case series was conducted on 116 patients suffering total knee arthroplasty in the Department of Orthopedics from August 2020 to September 2022. According to the mBP ratio of postoperation, the patients were divided into normal patella height, patella baja, and patella alta groups. The primary conditions, KSS, range of motion of keen, and patellar crepitus were collected from the patients in each group during follow-up. Outcome assessors were blinded to the groups during the study.

Results: There was no significant difference in the knee score of KSS among the groups (P=0.024); the patella baja group significantly differed in the range of motion compared to the normal patella group (*P=0.*037); a statistically significant difference existed in the patella baja group and the normal patella group for the patellar crepitus (P<0.001).

Conclusion: In the patients who underwent the total knee arthroplasty without patella replacement, it was found that abnormal patella position had no significant influence on postoperative KSS, but patella baja seemed to reduce the postoperative range of motion, and increase the rate of patella crepitus.

Keywords: Patella height; Total knee arthroplasty; Knee society score; Modified Blackburne-Peel ratio; Patellar crepitus.

Introduction

Osteoarthritis is the most common joint lesion in adults worldwide [1]. Osteoarthritis of the knee has the highest prevalence of 6% [2]. As society ages, the prevalence of osteoarthritis of the knee is increasing [3]. For patients with end-stage knee osteoarthritis, the effective treatment is Total Knee Arthroplasty (TKA), which corrects the knee deformity and restores the biological force line of the lower extremity. The postoperative satisfaction rate is 80-90% [4]. The mutation of patellar height is one of the most important factors affecting the prognosis of TKA patients, and the mutation of patellar height will cause a corresponding change in the contact force of the patellofemoral joint, resulting in postoperative patellofemoral joint-related complications including anterior knee pain, maltracking, fracture, avascular necrosis and patellar clunk [5].

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The patella acts as a mechanical lever for the patellofemoral joint, increasing the torque of the quadriceps muscle and increasing the efficiency of quadriceps knee extension by 50%, the patella also increases the surface area of the knee extension contact force and helps to recruit extensor muscle strength [6]. Abnormal patellofemoral position can therefore lead to limited knee motion and patellofemoral joint complications after TKA. Meanwhile, the patellofemoral joint is subject to significant surface stresses during daily activities, up to 2.5-7.6 times the body weight [7]. Therefore, maintaining the normal position of the patella is essential to reduce surface stress on the patellofemoral joint and to achieve a better prognosis after surgery.

On the one hand, the influence of patellar height mutation after TKA is rarely reported. On the other hand, the modified Blackburne-Peel (mBP) ratio [8,9] is an improved method to measure the change in patella height but is infrequently combined with follow-up data to explore the relation between patella position and joint function of TKA patients. Hence, we retrospectively analyzed the follow-up data of patients who underwent total knee arthroplasty in a single orthopedic center to investigate the effect of patellar height change on knee function by using the mBP ratio to evaluate the patellar position in this study.

Materials and methods

The study was approved by the ethics committee of the First Hospital of Jilin University, and the need for informed consent was waived by the ethics committee since only anonymized patient data were used for the study. The study was performed in accordance with the Declaration of Helsinki.

This study retrospectively analyzed patients who underwent total knee replacement surgery in our department from September 2019 to October 2022. A total of 171 knees of 116 patients were included, of which 25 (34 knees) were male and 91 (137 knees) were female. The mBP index was measured on lateral radiographs of the knee before and after surgery using the measurement software Digimizer from MedCalc Software Ltd. Postoperative patients were grouped according to their postoperative mBP index and divided into a patellar alta group, a normal patellar group, and a patellar baja group. The mBP ratio was were used to assess patellar height on true lateral radiographs in approximately 30 degrees of flexion and in weight-bearing conditions to guarantee a tensed patellar tendon at full length. The BPR was measured as the length of an orthogonal line from the joint line divided by the patellofemoral joint surface and the normal range is 0.54~1.06 [9]. The mBP ratio was measured by three orthopedic surgeons and took the average value. If the results of the same patient were a large discrepancy, it would be discussed after measurement by a superior surgeon. The precision of digital radiographic measurement was beyond two decimals.

All patients were operated on by the same joint surgeon and his team according to standard knee replacement techniques. All patients were placed in the supine position with general anesthesia and an inflatable electric tourniquet was placed at the base of the affected thigh. The usual surgical field was disinfected and a medial parapatellar approach was made in the anterior mid-knee to remove the infrapatellar fat pad, distract the patella outward and turn the patella moderately. After removal of the cruciate ligament and meniscus, the knee was dislocated and osteotomized, preserving a certain posterior tibial tilt angle and osteotomy using extramedullary positioning; a suitable type of femoral and tibial prosthesis was selected and the trial-molded prosthesis was fixed using bone cement and a suitable polyethylene spacer was placed. Without patellar replacement, the patella was trimmed and the peripatellar area was denervated, a drainage tube was placed, and the incision was closed layer by layer.

Postoperatively, all patients were invited to have an outpatient review at 2 months, 6 months, and 1 year and once a year thereafter. The data of follow-up included clinical and radiological examination, the complications, Range of Motion (ROM), Knee Society Score (KSS), and patellar crepitus were recorded for the postoperative follow-up of patients.

Statistical analysis

All statistical analyses were performed using SPSS software (IBM SPSS Statistics, Version 25). Metric data are presented as mean ± standard deviation (SD) (x±), and t-tests were performed. Nominal data are expressed as interquartile and percentages (M (IQR)), and the rank sum test was performed for comparison. Enumeration data were expressed as rates, and chi-square tests were performed. The Mann-Whitney U test was used to compare non-parametric variables, whereas the Wilcoxon signed-rank test was used to compare related samples of non-parametric data. *P*-value<0.05 was defined that the differences were statistically significant.

Results

From 2019 to 2022, 116 patients (171 knees of TKA) were identified, of whom two patients had cerebral infarction and one patient had cerebral hemorrhage during the follow-up period, and the remaining patients were well followed up. The mean follow-up time was 15.2 months.

After TKA, there were 29 knees in the patella baja group, with a male to female ratio of 1:2; 10 knees in the patella alta group, with a male to female ratio of 2:3, and 132 knees in the normal patella group, with a male to female ratio of 9:35; there were no statistically significant differences in gender, age, body mass index and follow-up time within the groups (P>0.05) (Table 1).

Using Kruskal-Wallis univariate analysis, knee functional scores (H=8.813, *P=0*.012) and postoperative ROM (H=6.264, *P*=0.012) were statistically different between the groups (*P*<0.05). On the basis of this multiple comparisons using the Bonferroni method, knee functional scores were statistically different between the patella baja and patella alta groups (H=8.8813, Bonferroni corrected *P*=0.024). Where ROM of knee was statistically significant in the patella baja group versus the normal patella group (H=6.264, Bonfferroni corrected *P*=0.037) (Table 2).

After TKA, the overall mean number of incidental joint weakness was statistically different between the three groups (χ^2 =16.601, *P<0*.05), with the rate of incidental joint weakness in the patella baja being statistically different from the normal patella group (*P<0*.05); the overall mean number of patellar crepitus was statistically different between the three groups (χ^2 =21.008, *P*<0.05), and the rate of patella crepitus was significantly higher in patella baja group compared with normal patella groups (P<0.05) (Table 3).

After plotting a Point-fold Line Chart of the mBP ratio before and after TKA (Figure 1), it could be indicated that the preoperative mBP ratio (blue line) is mostly above the postoperative mBP ratio (red line), which demonstrated that some degree of decrease in patellar height occurred in patients after TKA (Figure 1).

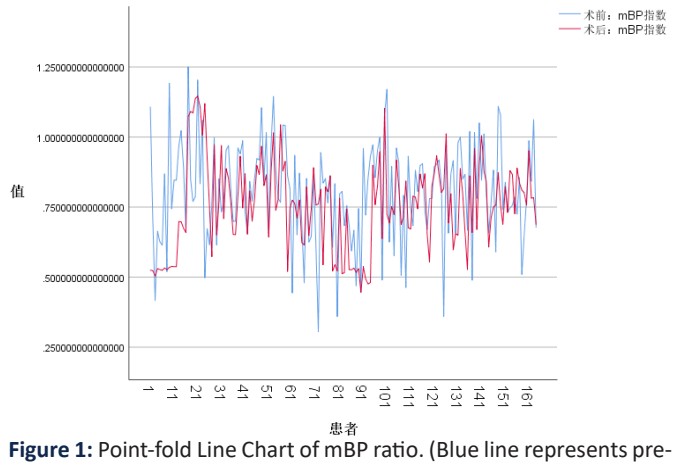

Figure 1: Point-fold Line Chart of mBP ratio. (Blue line represents preoperative data, and the red line represents postoperative data).

A scatterplot of ROM was performed and a best-fitted line was added to the figure showing that preoperative ROM is a good predictor for postoperative ROM (Figure 2).

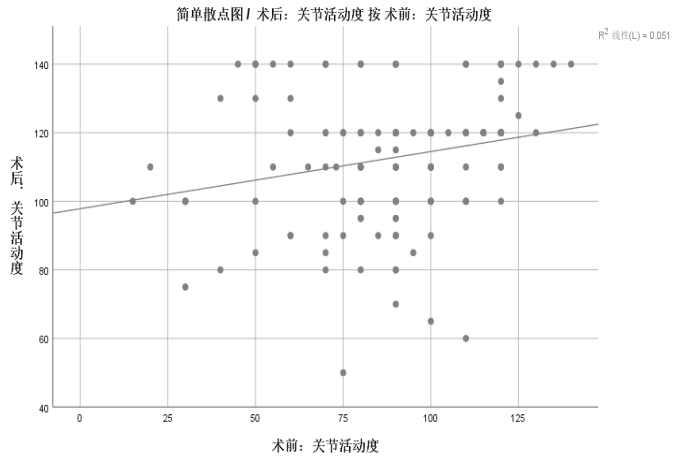

Figure 2: Scatterplot of ROM (The abscissa is the preoperative ROM, and the vertical axis is the postoperative ROM).

Table 1: Characteristics of patients.

		Patellar baja group	Patellar alta group	Normal patella group	Statistical values#	*P*-value
Gender	Male	9	4	27	3.109	0.228
	Female	18	6	105		
Age (years)		58.69 ± 11.83	64.32 ± 8.40	64.83 ± 8.44	1.522	0.223
BMI (kg/m^2)		26.98 ± 4.84	26.28 ± 4.40	26.03 ± 3.94	0.338	0.714
Follow-up time (months)		14.64 ± 9.60	22.00 ± 8.68	14.84 ± 8.84	2.814	0.063

Note: *statistically different from the Patella alta group; # statistically different from the normal patella group.

Table 2: Comparison of KSS and ROM in patients after TKA.

	Patella bajar group	Patella alta group	Normal patella group	H-value	*P*-value
Knee score (points)	92.5 (18.5)	95.0 (3.5)	95.0 (11.0)	3.782	0.151
Knee Function Score (points)	80.0 (50.0) *	100.0 (10.0)	100.0 (20.0)	8.813	0.012
ROM	97.5 (40.0) #	110.0 (25.0)	110.0 (20.0)	6.264	0.044

Table 3: Comparison of complication rates in patients after TKA.

		Patella bajar group	Patella alta group	Normal patella group	χ^2 value	P-value
Incidental weakness of the joints	None	15 (53.6)	7 (77.8)	113 (86.9)	16.601	0.0005
[Example (%)]	Existence	13 (46.4) *	2 (22.2)	17 (13.1)		
Patella crepitus	None	8 (28.6)	6 (66.7)	96 (73.8)	21.008	0.00001
[Example (%)]	Existence	20 (71.4) *	3 (33.3)	34 (26.2)		

Note: *statistically different from the Patella alta group.

Discussion

TKA is an effective treatment for knee diseases, however, the postoperative patellofemoral complication rate is as high as 1.3% to 50% due to the complexity of the biomechanical and anatomical characteristics of the patellofemoral joint [10-12]. The abnormal patellofemoral position can cause anterior knee pain, limited ROM of knee, joint instability, and patellofemoral clunk syndrome after TKA [13].

The rate of abnormal position of the patella is 11.0% to 26.4% after TKA [14-17]. In this study of 171 consecutive cases enrolled after TKA, the rate of patella baja was 17.0%, and the rate of patella alta after surgery was 5.8%. The functional score of KSS was significantly different between the Patella baja group and the Patella alta group. As pain assessment scores comprise a larger por-

tion contrasted with ROM scores in the knee score of KSS and the pain of the joint is remarkably alleviated after TKA, the KSS was not statistically different between patella baja group and normal patellar group, despite ROM of knee significantly decreased in patella baja group. Kazemi SM, Bugelli G, and Gaillard R et al found that KSS were not statistically different between the abnormal patella group and the normal patella group [16-18]. This study indicated a statistical difference in postoperative joint mobility between the patella baja group and the normal patella group, which is consistent with the findings of Kazemi SM and Schwab JH et al [18,19]. The changes of joint line position could cause mutation in patellar height, which resulted in polyethylene spacer wear and reduced knee joint stability [20]. Therefore, to improve ROM and reduce the rate of complications associated with patella baja after TKA, surgeons should perform a careful preoperative X-ray assessment, operate carefully during surgery, bring the reconstructed joint line as close as possible to the native joint line, and invite patients to take long-term regular follow-up and rehabilitation exercises.

Hozack WJ et al. were the first to report the patellar crepitus or clunk syndrome after TKA, and they concluded the mechanism was intercondylar impingement by fibrous nodules located in the junction of the upper pole of the patella and the quadriceps tendon passing the femoral condyle prosthesis [21]. Nam D et al. demonstrated the rate of patella crepitus was 45% after using the posterior stabilized (PS) prosthesis [22], which was much higher than other types of prostheses [23]. The overall rate of patellar crepitus in our study was 34.1%. The rate of patellar crepitus was found to be significantly increased in the patella baja group when compared to the normal patella group. Yau WP et al. indicated that postoperative lower patellar position was associated with the rate of patellar crepitus [24]. Moreover, Conrad DN et al. showed that the design and position of the prosthesis were closely related to patellar crepitus [25]. Pollock et al. revealed furtherly that the higher the intercondylar box and the narrower the width, the higher the rate of patellar crepitus [26]. Interestingly, Schroer WC et al. found that the greater the postoperative joint flexion angle, the higher the rate of patellar crepitus [27]. Therefore, to reduce the rate of patellar rattles after TKA, prosthesis designers could improve the prosthesis by reducing the intercondylar box ratio, increasing the lateral flange of the femoral prosthesis, and extending the gliding groove [28]. Surgeons might choose to use a prosthesis with a lower intercondylar box ratio and repair the joint line according to the assessment of the condition preoperatively, thereby reducing the rate of patellar crepitus and incidental joint weakness after TKA.

This study found that preoperative ROM of knee was a strong predictor for postoperative ROM, which is consistent with the findings of Konrads C et al [29]. Bourne RB et al. discovered that preoperative expectations were a risk factor for the postoperative satisfaction of patients after TKA [30]. This suggests that when orthopedic doctors that patients have poor preoperative joint mobility, they should appropriately subside expectations of patients for postoperative outcomes.

Several limitations in this study should be noted. (1) The sample size included in the study was small. (2) The follow-up period should be continued for a more long-term follow-up to explore the evolution of postoperative KSS, ROM, and patellar height over time. (3) The PS prostheses used in this research were not categorized according to different manufacturers. (4) None of the TKA patients in this study underwent patellar replacement.

Conclusion

The clinical finding of this study is that abnormal patellar position did not affect postoperative KSS compared with normal patella position. Still, the patella baja seemed to reduce postoperative ROM, and increase the rate of patellar crepitus. Therefore, surgeons should be aware of planning a customized preoperative plan, performing proper intraoperative operations and prosthesis selection, and instructing patients to achieve functional recovery exercises early after TKA, to reduce the rate of patella baja and enhance postoperative ROM.

Declarations

Ethics approval and consent to participate: The study was approved by the ethics committee of the First Hospital of Jilin University, and the need for informed consent was waived by the ethics committee since only anonymized patient data were used for the study. The study was performed in accordance with the Declaration of Helsinki.

Consent for publication: All data generated or analysed during this study are included in this published article.

Availability of data and materials: Not applicable

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