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Original Research Article

Radiological Restoration of Posterior Condylar Offset After Total Knee Arthroplasty and Its Influence on Postoperative Knee Flexion: A Prospective Study

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Abstract

Background: Posterior condylar offset (PCO) is an important determinant of knee biomechanics after total knee arthroplasty (TKA), although its influence on postoperative knee flexion remains controversial.

Objective: To evaluate radiological restoration of posterior condylar offset following primary TKA and determine its influence on postoperative knee flexion and functional outcomes.

Methods: This prospective observational study included 40 patients undergoing primary cruciate-sacrificing TKA. Preoperative and postoperative PCO were measured on standardized lateral radiographs. Clinical outcomes were assessed using knee flexion and Knee Society Score (KSS) preoperatively and at 2 weeks, 1 month, and 3 months postoperatively. Statistical analysis included paired t-test, repeated-measures ANOVA, Friedman test, and Pearson's correlation.

Results: The mean age was 62.67 ± 8.44 years, and 65.0% of patients were female. Mean PCO decreased significantly from 27.16 ± 2.47 mm to 26.34 ± 3.21 mm ($p=0.012$). Knee flexion improved significantly from 95.10 ± 12.46° to 113.85 ± 13.62°, while the mean total KSS increased from 45.58 ± 7.98 to 79.60 ± 8.10 (both $p<0.001$). However, no significant correlation was observed between change in PCO and postoperative knee flexion ($r = -0.062$, $p = 0.705$) or total KSS ($r = -0.137$, $p = 0.399$). Overall, 92.5% of patients achieved good-to-excellent functional outcomes.

Conclusion: Primary TKA resulted in significant improvement in knee flexion and functional outcomes. Although a small reduction in posterior condylar offset was observed, changes in PCO did not significantly influence postoperative knee flexion or Knee Society Score.

Keywords: Total Knee Arthroplasty; Posterior Condylar Offset; Knee Flexion; Knee Society Score; Functional Outcome.

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Introduction

Total knee arthroplasty (TKA) is the gold standard surgical treatment for end-stage degenerative knee diseases, particularly osteoarthritis, providing reliable pain relief, correction of deformity, restoration of function, and improved quality of life. With increasing life expectancy and the growing prevalence of osteoarthritis, the number of primary TKA procedures continues to rise worldwide. Despite advances in implant design and surgical techniques, postoperative functional outcomes, especially knee flexion, remain variable, emphasizing the importance of restoring normal knee biomechanics during surgery [1].Successful restoration of knee kinematics after TKA depends on accurate component positioning, balanced soft tissues, and preservation of important anatomical parameters. Among these, posterior condylar offset (PCO), defined as the perpendicular distance between the posterior femoral cortex and the most posterior point of the femoral condyles on a true lateral radiograph, has gained considerable attention. Accurate radiographic measurement of PCO is reproducible and serves as an important indicator of restoration of distal femoral anatomy

following arthroplasty [2,3].Biomechanically, PCO facilitates posterior femoral rollback during knee flexion, maintains the flexion gap, minimizes posterior impingement, and permits greater postoperative range of motion. Reduction in PCO may lead to impaired femoral rollback, flexion instability, and limited postoperative flexion, whereas excessive restoration may overstuff the flexion gap and increase soft-tissue tension. Consequently, restoration of native PCO has become an important surgical objective to optimize knee biomechanics and functional performance after TKA [4,5].Postoperative knee flexion is one of the strongest determinants of patient satisfaction because it directly influences activities of daily living such as stair climbing, sitting, rising from a chair, squatting, and kneeling. Although postoperative range of motion is affected by several factors including preoperative flexion, implant design, surgical technique, rehabilitation, and patient characteristics, restoration of PCO remains one of the few surgically modifiable factors. Previous studies have suggested that preservation of PCO, together with appropriate posterior tibial slope, contributes to improved postoperative knee flexion and functional recovery [5,6].However, the relationship between restoration of PCO and postoperative functional outcome remains controversial. While some studies have demonstrated that preservation of PCO improves knee flexion and clinical outcomes, others have reported little or no association, suggesting that postoperative function depends on multiple biomechanical and patient-related factors rather than PCO alone. Recent clinical and biomechanical studies continue to report conflicting findings, warranting further investigation [7–10].

Evidence regarding the influence of PCO restoration on postoperative outcomes remains limited in the Indian population, where activities requiring deep knee flexion are common in daily life. Therefore, the present prospective study was undertaken to evaluate the radiological restoration of posterior condylar offset following primary total knee arthroplasty and to determine its influence on postoperative knee flexion and functional outcomes.

Materials and Methods

Study Design and Setting: This prospective observational study was conducted in the Department of Orthopaedics, Sapthagiri Hospital, Sapthagiri Institute of Medical Sciences and Research Centre (SIMSRC), Bengaluru, India, over a period of 18 months (May 2024 to October 2025). The study evaluated radiological restoration of posterior condylar offset (PCO) following primary total knee arthroplasty (TKA) and its influence on postoperative knee flexion and functional outcomes.

Study Population: Forty consecutive patients undergoing primary total knee arthroplasty were enrolled.

Inclusion Criteria

- Patients aged 45–80 years undergoing primary TKA.
- Patients receiving a cruciate-sacrificing total knee prosthesis.
- Patients willing to provide written informed consent.

Exclusion Criteria

- Neurovascular insufficiency of the affected limb.
- Previous lower-extremity joint replacement or surgery.
- Body mass index (BMI) >35 kg/m².
- Inability to walk without a walking aid.
- Associated knee ligament injuries.
- Visual disorders affecting gait or balance.

Surgical Procedure: All procedures were performed by experienced orthopaedic surgeons using a standardized medial parapatellar approach.

A cemented cruciate-sacrificing total knee prosthesis was implanted in all patients. Standardized femoral and tibial bone cuts, soft-tissue balancing, and appropriate femoral component positioning were performed with emphasis on restoring posterior condylar offset. A uniform postoperative rehabilitation protocol was followed for all patients.

Radiological Assessment: Standardized true lateral radiographs of the knee were obtained preoperatively and postoperatively. Posterior condylar offset (PCO) was measured as the perpendicular distance between the posterior femoral cortex and the most posterior point of the femoral condyle. The change in PCO was calculated by subtracting the preoperative value from the postoperative value.

Clinical Assessment: Clinical evaluation included the Knee Society Score (KSS) and active knee flexion measured using a standard goniometer. Patients were assessed preoperatively and at 2 weeks, 1 month, and 3 months after surgery.

Outcome Measures

Primary Outcome

- Association between change in posterior condylar offset and postoperative knee flexion.

Secondary Outcomes

- Improvement in Knee Society Score (KSS).
- Serial changes in postoperative knee flexion.
- Early postoperative complications.

Data Collection: Demographic, clinical, operative, radiological, and follow-up data were prospectively recorded using a structured case record form. Data were entered into Microsoft Excel and verified before statistical analysis.

Statistical Analysis: Statistical analysis was performed using IBM SPSS Statistics software. Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range), while categorical variables were expressed as frequencies and percentages. Normality was assessed using the Shapiro–Wilk test. Paired t-test or Wilcoxon signed-rank test was used for pre- and postoperative comparisons. Repeated-measures ANOVA or Friedman test was used to evaluate changes over follow-up, and Pearson's correlation coefficient was used to assess the association between PCO change and functional outcomes. A p-value <0.05 was considered statistically significant.

Ethical Considerations: The study was approved by the Institutional Ethics Committee of Sapthagiri Institute of Medical Sciences and Research Centre, Bengaluru. Written informed consent was obtained from all participants prior to enrolment, and confidentiality of patient information was maintained throughout the study.

Results

A total of 40 patients undergoing primary total knee arthroplasty were included in the study. The mean age of the study population was 62.67 ± 8.44 years (range, 48–79 years), with the highest proportion of patients in the 56–60 years age group (25.0%). Females constituted 65.0% of the study population. Osteoarthritis was the predominant indication for surgery (95.0%), and varus deformity was present in 75.0% of patients. Baseline demographic and clinical characteristics are summarized in (Table 1).Most procedures were performed under spinal anaesthesia (70.0%). The mean duration of surgery was 94.53 ± 15.64 minutes, and the mean hospital stay was 7.78 ± 2.14 days. The mean posterior condylar offset (PCO) decreased significantly from 27.16 ± 2.47 mm preoperatively to 26.34 ± 3.21 mm postoperatively, with a mean reduction of 0.82 ± 1.97 mm ($p = 0.012$) (Table 2, Figure 1).Clinical outcomes improved significantly following surgery. Mean knee flexion increased from 95.10 ± 12.46° preoperatively to 113.85 ± 13.62° at 3 months, while the extension deficit improved from 7.78 ± 3.58° to 3.05 ± 3.36° (both $p < 0.001$). Similarly, the mean total Knee Society Score (KSS) improved significantly from 45.58 ± 7.98 to 79.60 ± 8.10 ($p < 0.001$). Significant improvements were also observed in the individual KSS domains of pain, stability, and range of motion (Table 3, Figure 2).

Longitudinal analysis demonstrated progressive improvement in functional outcomes throughout the follow-up period. Repeated-measures ANOVA and Friedman test both confirmed significant improvements in knee flexion ($F = 213.2$, $\chi^2 = 104.962$, $p < 0.001$) and total KSS ($F = 734.1$, $\chi^2 = 119.707$, $p < 0.001$) across serial follow-up visits (Table 4).Correlation analysis showed no significant relationship between postoperative change in PCO and functional outcomes. The correlation between PCO change and knee flexion at 3 months was weak and non-significant ($r = −0.062$, $p = 0.705$). Likewise, no significant correlation was observed between PCO change and total KSS ($r = −0.137$, $p = 0.399$).

Similar non-significant correlations were noted at 2 weeks and 1 month after surgery (Table 5).At the final follow-up, 47.5% of patients achieved an excellent KSS outcome, 45.0% had a good outcome, and 7.5% had a fair outcome, with no patient demonstrating a poor result. There was no significant association between the magnitude of PCO change and postoperative KSS grade (Fisher's exact test, $p = 0.082$). Postoperative wound healing was satisfactory in the majority of patients (87.5%), while wound dehiscence, discharge, and superficial infection were observed in 7.5%, 2.5%, and 2.5% of patients, respectively (Tables 6A and 6B, Figure 3).

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population (N = 40)

Characteristic	Category	n (%) / Mean ± SD
Age (years)	Mean ± SD	62.67 ± 8.44
	Range	48–79
	45–50	4 (10.0)
	51–55	3 (7.5)
	56–60	10 (25.0)
	61–65	7 (17.5)
	66–70	7 (17.5)
	71–75	7 (17.5)
	76–80	2 (5.0)
Gender	Female	26 (65.0)
	Male	14 (35.0)

Side involved	Right	20 (50.0)
	Left	14 (35.0)
	Bilateral	6 (15.0)
Primary diagnosis	Osteoarthritis	38 (95.0)
	Rheumatoid arthritis	2 (5.0)
Knee deformity	Varus	30 (75.0)
	Valgus	3 (7.5)
	None	7 (17.5)

Table 2: Perioperative Characteristics and Radiological Outcomes (N = 40)

Variable	Value
Anaesthesia	
Spinal anaesthesia	28 (70.0)
General anaesthesia	8 (20.0)
Combined spinal anaesthesia	4 (10.0)
Duration of surgery (minutes), Mean ± SD	94.53 ± 15.64
Hospital stay (days), Mean ± SD	7.78 ± 2.14
Posterior condylar offset (mm)	
Preoperative PCO	27.16 ± 2.47
Postoperative PCO	26.34 ± 3.21
Mean change in PCO	−0.82 ± 1.97
Mean difference	−0.82 mm
Paired t value	−2.647
p-value	**0.012**

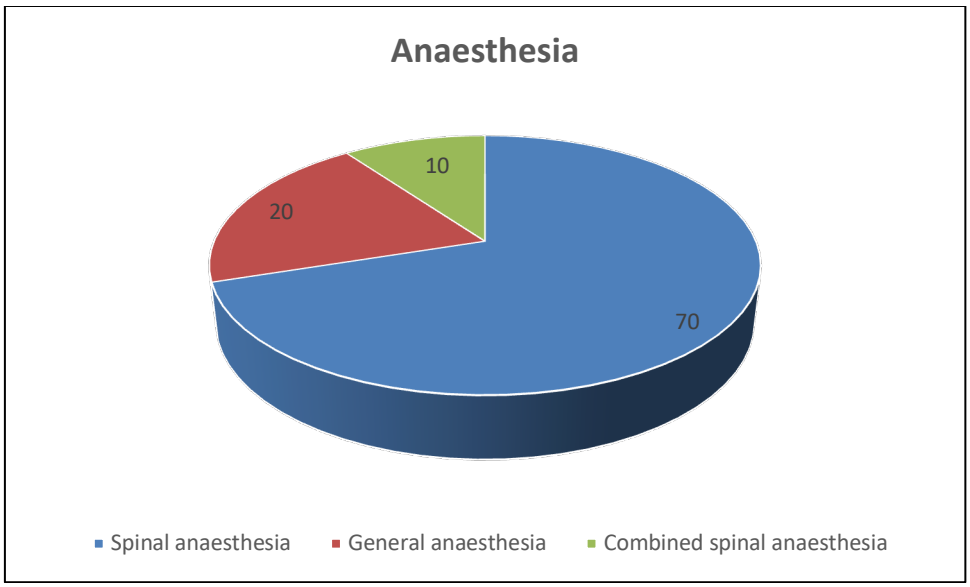

Figure 1: Perioperative Characteristics and Radiological Outcomes

Table 3: Comparison of Clinical Outcomes before and After Total Knee Arthroplasty

Outcome	Preoperative Mean ± SD	3 Months Mean ± SD	Mean Difference	p-value
Knee flexion (°)	95.10 ± 12.46	113.85 ± 13.62	+18.75	<0.001
Extension deficit (°)	7.78 ± 3.58	3.05 ± 3.36	−4.73	<0.001
Total Knee Society Score	45.58 ± 7.98	79.60 ± 8.10	+34.02	<0.001
KSS Pain	19.62 ± 5.70	39.92 ± 6.58	+20.30	<0.001
KSS Stability	14.30 ± 4.29	20.32 ± 4.18	+6.02	<0.001
KSS ROM	11.65 ± 3.25	19.35 ± 3.71	+7.70	<0.001

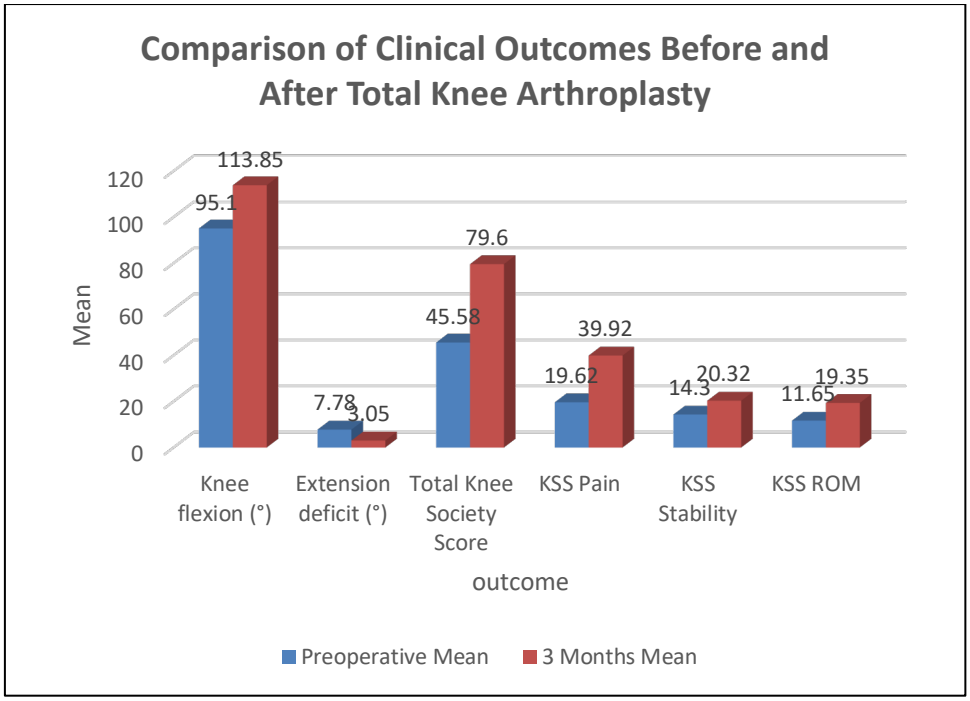

Figure 2: Comparison of Clinical Outcomes before and After Total Knee Arthroplasty

Table 4: Longitudinal Changes in Functional Outcomes Following Total Knee Arthroplasty (N = 40)

Outcome	Analysis	Test Statistic	p-value
Knee flexion	Repeated-measures ANOVA	F = 213.2	<0.001
	Friedman test	χ^2 = 104.962	<0.001
Total KSS	Repeated-measures ANOVA	F = 734.1	<0.001
	Friedman test	χ^2 = 119.707	<0.001

Table 5: Correlation between Change in Posterior Condylar Offset and Functional Outcomes

Variable	Pearson's r	95% Confidence Interval	p-value
Change in PCO vs Knee flexion (3 months)	−0.062	−0.366 to 0.255	0.705
Change in PCO vs Total KSS	−0.137	−0.430 to 0.182	0.399
Change in PCO vs Knee flexion (2 weeks)	−0.111	—	0.496
Change in PCO vs Knee flexion (1 month)	−0.067	—	0.681
Change in PCO vs Knee flexion (3 months)	−0.062	—	0.705

Table 6 A: Postoperative Functional Outcomes and Complications (N = 40)

Variable	Category	n (%)
Knee Society Score Grade	Excellent	19 (47.5)
	Good	18 (45.0)
	Fair	3 (7.5)
	Poor	0 (0.0)
Association of PCO change with KSS outcome	Fisher's exact test	p = 0.082

Table 6 B: Postoperative Functional Outcomes and Complications (N = 40)

Postoperative wound status	n (%)
Healthy	35 (87.5)
Dehiscence	3 (7.5)
Discharge	1 (2.5)
Infection	1 (2.5)

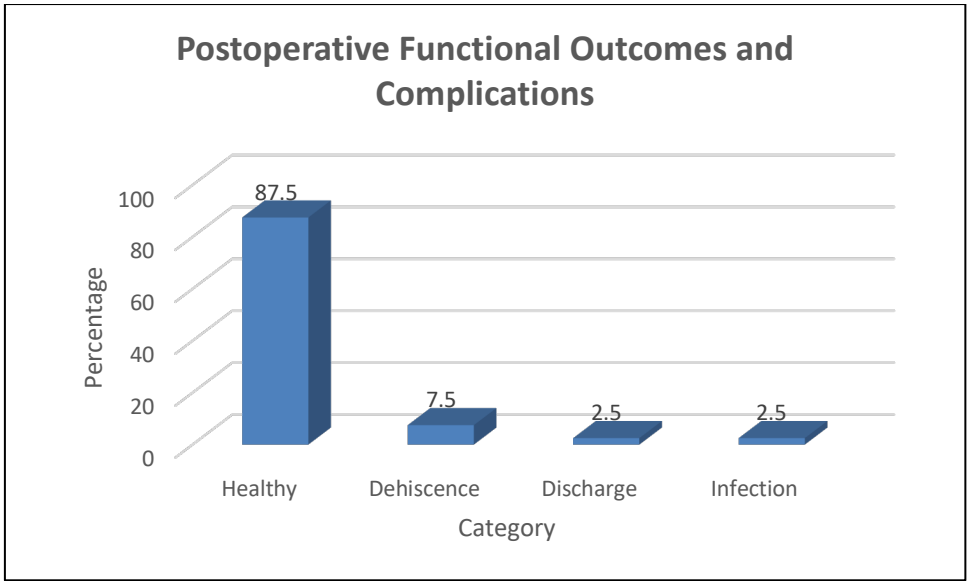

Figure 3: Postoperative Functional Outcomes and Complications (N = 40)

Discussion

In the present study, the mean preoperative posterior condylar offset (PCO) was 27.16 ± 2.47 mm, which decreased significantly to 26.34 ± 3.21 mm at 3 months after total knee arthroplasty (mean change −0.82 ± 1.97 mm, p=0.012). Although a statistically significant reduction was observed, 40.0% of patients maintained PCO within ±1 mm of the native anatomy, indicating satisfactory restoration in the majority of cases. Goldstein et al. [12] reported that preservation of posterior condylar offset is essential for maintaining the flexion gap and posterior femoral rollback. The authors concluded that restoration of PCO, combined with adequate clearance of the posterior condylar space, resulted in comparable postoperative knee flexion in both posterior cruciate-retaining and posterior-stabilized prostheses. Similarly, Massin and Gournay [13] demonstrated that optimization of posterior condylar offset together with appropriate tibial slope improved femoral rollback and restored more physiological knee biomechanics after TKA. Their findings support meticulous restoration of PCO during femoral component implantation. In the present study, postoperative knee flexion improved significantly from 95.10 ± 12.46° preoperatively to 113.85 ± 13.62° at 3 months (p<0.001). Repeated-measures analysis also demonstrated significant improvement in knee flexion throughout follow-up (F=213.2, p<0.001). Kawamura and Bourne [14] evaluated patients undergoing primary total knee arthroplasty and reported that preoperative range of motion was the strongest predictor of postoperative flexion, whereas severe preoperative deformity adversely affected final ROM. They concluded that restoration of normal knee mechanics and adequate rehabilitation were essential for achieving satisfactory postoperative flexion. Kurosaka et al. [15] emphasized that maximizing postoperative flexion requires appropriate femoral component positioning, balanced flexion gaps, and meticulous surgical technique. The authors also cautioned that excessive attempts to increase flexion may compromise knee stability. Likewise, Chiu et al. [16] found that postoperative knee flexion was influenced predominantly by preoperative ROM, implant positioning, and surgical technique rather than by any single radiological parameter. Similarly, Dennis et al. [17] concluded that postoperative flexion following TKA is multifactorial and depends on patient-related factors, implant design, soft-tissue balancing, rehabilitation, and restoration of knee biomechanics. These observations are in agreement with the marked improvement in knee flexion observed in the present study.

The present study demonstrated a significant improvement in functional outcome following TKA. The mean Knee Society Score (KSS) improved from 45.58 ± 7.98 preoperatively to 79.60 ± 8.10 at 3 months (p<0.001). Furthermore, 92.5% of patients achieved good-to-excellent postoperative outcomes. Goldstein et al. [11] observed that restoration of posterior femoral anatomy together with proper soft-tissue balancing resulted in satisfactory postoperative function irrespective of prosthesis design. Likewise, Massin and Gournay [12] reported that optimization of posterior condylar offset and femoral rollback contributed to improved knee biomechanics and enhanced functional recovery after total knee arthroplasty. The principal objective of the present study was to determine whether restoration of posterior condylar offset influences postoperative knee flexion. Correlation analysis demonstrated a weak negative, non-significant correlation between change in PCO and postoperative knee flexion (r =

−0.062, p = 0.705). Similarly, no significant correlation was observed between PCO change and improvement in total KSS (r = −0.137, p = 0.399). These findings are consistent with Ishii et al. (2013) [18], who evaluated 170 primary TKAs and reported no significant correlation between postoperative changes in posterior condylar offset and knee flexion. Their study showed mean changes in medial PCO of 0.0 ± 3.6 mm and −0.5 ± 3.3 mm in different implant groups, while postoperative flexion changes remained independent of PCO restoration. The authors concluded that restoration of posterior condylar offset alone did not determine postoperative range of motion.

In contrast, Kim (2013) [19] reported that preservation of posterior femoral condylar offset together with appropriate posterior tibial slope was associated with greater maximal postoperative knee flexion in posterior cruciate-sacrificing total knee arthroplasty. The author suggested that multiple anatomical factors collectively influence postoperative ROM rather than posterior condylar offset alone.

Conclusion

Primary total knee arthroplasty resulted in significant improvement in knee flexion, Knee Society Score, pain, stability, and overall functional outcome at 3 months.

Although posterior condylar offset was satisfactorily restored in most patients, postoperative changes in PCO showed no significant correlation with knee flexion or functional outcome. These findings suggest that restoration of PCO alone does not determine postoperative success, which is influenced by multiple surgical and patient-related factors.

Limitation

The study was limited by its single-centre design, relatively small sample size, and short follow-up period of three months. Larger multicentric studies with longer follow-up are needed to validate the long-term influence of posterior condylar offset on functional outcomes after total knee arthroplasty.

References

1. Goldblatt JP, Richmond JC. Anatomy and biomechanics of the knee. Oper Tech Sports Med. 2003;11(3):172-186.
2. Johal P, Hassaballa MA, Eldridge JD, Porteous AJ. The posterior condylar offset ratio. Knee. 2012;19(6):843-845.
3. Bao L, Rong S, Shi Z, Wang J, Zhang Y. Measurement of femoral posterior condylar offset and posterior tibial slope in normal knees based on 3D reconstruction. BMC Musculoskelet Disord. 2021;22:486.
4. Bellemans J, Banks S, Victor J, Vandenneucker H, Moemans A. Fluoroscopic analysis of the kinematics of deep flexion in total knee arthroplasty: influence of posterior condylar offset. J Bone Joint Surg Br. 2002;84(1):50-53.
5. Arabori M, Matsui N, Kuroda R, Mizuno K, Doita M, Kurosaka M, et al. Posterior condylar offset and flexion in posterior cruciate-retaining and posterior-stabilized TKA. J Orthop Sci. 2008;13(1):46-50.
6. Malviya A, Lingard EA, Weir DJ, Deehan DJ. Predicting range of movement after knee replacement: the importance of posterior condylar offset and tibial slope. Knee Surg Sports Traumatol Arthrosc. 2009;17(5):491-498.
7. Ishii Y, Noguchi H, Takeda M, Sato J, Toyabe SI. Posterior condylar offset does not correlate with knee flexion after TKA. Clin Orthop Relat Res. 2013;471(9):2995-3001.
8. Kang KT, Kwon SK, Kwon OR, Lee JS, Koh YG. Comparison of the biomechanical effect of posterior condylar offset and kinematics between posterior cruciate-retaining and posterior-stabilized total knee arthroplasty. Knee. 2019;26(1):250-257.
9. Panciera A, Digennaro V, Bogucki BD, Barile F, Manzetti M, Ferri R, et al. The role of posterior condylar offset ratio on clinical and functional outcome of posterior stabilized total knee arthroplasty: a retrospective cohort study. Eur J Orthop Surg Traumatol. 2023; 33(6): 2459-2464.
10. Goutham GD, Jain VK, Sinha S, Arya RK. Effect of posterior condylar offset in postoperative range of motion in cruciate retaining and sacrificing TKR: A comparative analysis. J Orthop. 2020;20:342-346.
11. Wang W, Yue B, Wang J, Bedair H, Rubash H, Li G. Posterior condyle offset and maximum knee flexion following a cruciate-retaining total knee arthroplasty. J Knee Surg. 2018;32(2):146–152.
12. Goldstein WM, Raab DJ, Gleason TF, Branson JJ, Berland K. Why posterior cruciate-retaining and substituting total knee replacements have similar ranges of motion: the importance of posterior condylar offset and cleanout of posterior condylar space. J Bone Joint Surg Am. 2006;88 Suppl 4:182-8.
13. Massin P, Gournay A. Optimization of the posterior condylar offset, tibial slope, and condylar roll-back in total knee arthroplasty. J Arthroplasty. 2006;21(6):889-96.
14. Kawamura H, Bourne RB. Factors affecting range of flexion after total knee arthroplasty. J Orthop Sci. 2001;6(3):248-52.
15. Kurosaka M, Yoshiya S, Mizuno K, Yamamoto T. Maximizing flexion after total

knee arthroplasty: the need and the pitfalls. J Arthroplasty. 2002;17(4 Suppl 1):59-62.
16. Chiu KY, Ng TP, Tang WM, Yau WP. Knee flexion after total knee arthroplasty. J Orthop Surg (Hong Kong). 2002;10(2):194-202.
17. Dennis DA, Komistek RD, Scuderi GR, Zingde S. Factors affecting flexion after total knee arthroplasty. Clin Orthop Relat Res. 2007;464:53-60.
18. Ishii Y, Noguchi H, Takeda M, Sato J, Toyabe SI. Posterior condylar offset does not correlate with knee flexion after TKA. Clin Orthop Relat Res. 2013;471(9):2995-3001.
19. Kim JH. Effect of posterior femoral condylar offset and posterior tibial slope on maximal flexion angle of the knee in posterior cruciate ligament-sacrificing total knee arthroplasty. Knee Surg Relat Res. 2013;25(2):54-9.