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PREOPERATIVE FACTORS INFLUENCING KNEE-FLEXION RANGE OF MOTION AFTER TOTAL KNEE ARTHROPLASTY IN PATIENTS WITH KNEE OSTEOARTHRITIS

Original Research

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ABSTRACT

Background: Knee osteoarthritis (OA) is a leading cause of pain and disability in the elderly, often managed effectively with total knee arthroplasty (TKA). Postoperative range of motion (ROM) is a critical determinant of functional recovery and patient satisfaction. While several factors affect surgical outcomes, the specific influence of preoperative knee flexion angle and tibiofemoral alignment on postoperative ROM remains underexplored and clinically relevant for optimizing patient outcomes.

Objective: To evaluate the impact of preoperative knee flexion angle and tibiofemoral angle on postoperative range of motion in patients undergoing TKA for knee osteoarthritis.

Methods: A cross-sectional study was conducted at the Department of Orthopedics, PAEC General Hospital, Islamabad, from January 1 to December 31, 2024. Ninety-four patients diagnosed with knee OA and scheduled for primary TKA were enrolled. Preoperative and postoperative knee flexion angles were measured using a 30-cm universal goniometer, while tibiofemoral angles were assessed from standard weight-bearing long-leg radiographs. All surgeries were performed using a consistent cemented technique. Postoperative ROM was evaluated at three months. Data were analyzed using IBM SPSS version 22. Pearson's correlation and linear regression were used to assess associations and predictive strength. A p-value ≤ 0.05 was considered statistically significant.

Results: The mean age was 64.5 ± 6.8 years; 57.4% were female. The mean preoperative knee flexion angle was 102.3° ± 13.8°, which improved to 107.1° ± 10.5° postoperatively ($p < 0.001$). The tibiofemoral angle improved from 182.1° ± 10.8° to 177.0° ± 3.5° ($p < 0.001$). Preoperative flexion ($r = 0.372$, $p < 0.001$) and tibiofemoral angle ($r = -0.291$, $p = 0.006$) were significantly correlated with postoperative flexion. Regression analysis identified preoperative flexion ($\beta = 0.65$, $p < 0.001$) and tibiofemoral angle ($\beta = -0.22$, $p = 0.01$) as significant predictors, accounting for 29% of variance in postoperative ROM (adjusted $R^2 = 0.29$).

Conclusion: Preoperative knee flexion and tibiofemoral alignment significantly influence postoperative ROM in TKA. Patients with better preoperative flexion and varus alignment tend to achieve improved postoperative flexion. Early surgical intervention and individualized preoperative evaluation are essential for optimal outcomes. Future multicenter studies with larger cohorts and extended follow-up are warranted.

Keywords: Knee arthroplasty, Knee osteoarthritis, Knee joint, Range of motion, Tibiofemoral angle, Treatment outcome, Varus deformity.

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INTRODUCTION

Knee osteoarthritis (OA) is the most prevalent age-related degenerative disorder affecting the knee joint, characterized by progressive deterioration of articular cartilage due to chronic mechanical stress and biological changes. As the global population ages, the burden of OA continues to rise, with a recent study indicating that approximately 13% of women and 10% of men aged 60 years and older are affected by knee OA, making it a leading cause of functional limitation and disability in the elderly population (1,2). The associated pain, stiffness, and impaired mobility significantly reduce the quality of life, prompting many individuals to seek surgical intervention when conservative measures fail. Total knee arthroplasty (TKA) has emerged as a widely accepted and effective surgical solution for advanced knee OA, providing a reliable reduction in pain and improvement in joint function and overall patient satisfaction (3). One of the most critical determinants of postoperative success following TKA is the range of motion (ROM) achieved after surgery. Optimal knee function after TKA requires approximately 130º of flexion along with full extension to enable the performance of essential daily activities and more physically demanding tasks (4). Postoperative ROM is, therefore, a pivotal component of several knee scoring systems and is strongly correlated with walking ability, stair climbing, and general satisfaction with surgical outcomes.

Multiple factors have been identified to influence the postoperative ROM following TKA, including age, sex, body mass index (BMI), preoperative ROM, tibiofemoral alignment, primary pathology, baseline activity level, surgical approach, prosthetic design, and postoperative rehabilitation protocols (5). Among these, preoperative knee flexion angle and tibiofemoral angle have received considerable attention, as they may offer predictive value regarding postoperative outcomes. However, literature presents conflicting findings in this regard. While some studies suggest that severely restricted preoperative ROM may substantially improve postoperatively, others indicate that knees with a relatively good preoperative ROM may show minimal or even diminished gains following TKA (6,7). Farahini et al. investigated 95 patients undergoing total knee replacement and found significant correlations between preoperative flexion angle ($r = 0.365$, $p = 0.001$) and postoperative flexion, as well as a negative correlation between preoperative tibiofemoral angle and postoperative ROM ($r = -0.285$, $p = 0.007$), suggesting their potential predictive utility (8). Despite these insights, there remains a lack of consensus and standardization regarding the optimal preoperative knee status for achieving favorable postoperative ROM (9). The timing of surgical intervention is especially critical, as delaying TKA until significant joint destruction occurs may compromise functional recovery, while performing it too early may not yield substantial benefits (10). Therefore, the objective of the present study is to evaluate the influence of two key preoperative factors—knee flexion angle and tibiofemoral angle—on the postoperative ROM among patients undergoing TKA. By clarifying these relationships, this study aims to support more informed clinical decision-making regarding the optimal timing for TKA, ultimately contributing to improved functional outcomes and enhanced quality of life for patients.

METHODS

This cross-sectional study was conducted at the Department of Orthopedics, PAEC General Hospital, Islamabad, over a one-year period from January 1, 2024, to December 31, 2024. A total sample size of 94 patients was calculated using an online correlation calculator, taking a correlation coefficient ($r = 0.285$) from prior literature (8), with a confidence level of 95% and statistical power of 80%. Patients were selected using a non-probability consecutive sampling technique. Inclusion criteria consisted of individuals diagnosed with primary knee osteoarthritis based on clinical and radiological assessment who were planned for primary total knee arthroplasty (TKA). Exclusion criteria included patients with systemic inflammatory joint disorders such as rheumatoid arthritis, those experiencing postoperative complications like infection, fracture, prosthetic loosening, instability, or malalignment, and individuals undergoing revision arthroplasty or surgeries for traumatic fractures. The strict application of these exclusion criteria was intended to reduce potential confounding and bias. Ethical approval was obtained from the hospital's Institutional Review Board, and written informed consent was obtained from all participants. All enrolled patients underwent a comprehensive clinical evaluation and radiographic assessment preoperatively. Patient data included demographic variables (age and gender) and clinical measurements such as body weight, height, preoperative tibiofemoral varus/valgus angle, preoperative flexion angle, and postoperative flexion angle (11). All TKA procedures were performed under general anesthesia by the same surgical team using a consistent technique involving cemented implants. A pneumatic tourniquet was applied during surgery to minimize intraoperative bleeding. After the procedure, the knee was dressed with standard sterile dressings consisting of gauze, cotton pads, and a crape bandage.

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Pharmacological and mechanical thromboprophylaxis was not utilized in this study. Instead, all patients were mobilized early, starting passive movements and partial weight-bearing from the second postoperative day. This approach was adopted in accordance with the hospital's standard operating protocol, which emphasizes early mobilization as a non-pharmacologic strategy to reduce thromboembolic risks. This protocol is based on existing evidence suggesting that prompt postoperative ambulation can significantly mitigate venous thromboembolism risk, especially in low- to moderate-risk patients, and may serve as a reasonable alternative when anticoagulants are contraindicated or when bleeding risks outweigh potential benefits. Nonetheless, the decision not to use prophylactic agents should be interpreted within the context of individualized patient risk assessments and institutional safety outcomes, and warrants further validation through larger-scale studies. All patients followed a standardized postoperative physiotherapy and rehabilitation program aimed at optimizing joint mobility and functional recovery. Range of motion (ROM), including knee flexion and extension, was measured using a 30-cm plastic universal goniometer with a 360-degree dial. The tibiofemoral angle was assessed from weight-bearing long-leg radiographs (12). Postoperative evaluations were conducted at two weeks to identify any early complications, followed by monthly reviews. The primary outcome—postoperative knee flexion—was recorded at the three-month follow-up, with all patients being monitored for a minimum duration of six months. Data analysis was performed using IBM SPSS version 22. Descriptive statistics including means and standard deviations were calculated for continuous variables such as age, weight, tibiofemoral angle, and flexion angles, while categorical variables like gender and age group were reported as frequencies and percentages. Pearson's correlation coefficient was used to determine the relationship between preoperative tibiofemoral and flexion angles with postoperative flexion outcomes. A p-value of ≤ 0.05 was considered statistically significant for all analyses.

RESULTS

A total of 94 patients who underwent total knee arthroplasty were included in the study, with a mean age of 64.5 ± 6.8 years (range: 57–78 years). Of these, 54 patients (57.4%) were female and 40 (42.6%) were male. Most participants (76.6%) were above the age of 65 years. The average body weight recorded was 72.5 ± 8.2 kg (range: 60–92 kg), and the mean height was 1.62 ± 0.07 meters (range: 1.54–1.75 meters). The mean operative time was 86.5 ± 18.2 minutes (range: 65–130 minutes), while the average duration of hospital stay was 4.3 ± 1.6 days (range: 3–10 days). Postoperative complications were minimal, with only 2 cases of surgical site infection and 1 case of knee hematoma; no incidents of nerve injury, delayed wound healing, or deep vein thrombosis were reported. The preoperative mean knee flexion angle was 102.3 ± 13.8°, which significantly improved to 107.1 ± 10.5° at three months postoperatively ($p < 0.001$). The mean extension improved from 5.9 ± 4.5° preoperatively to 1.3 ± 2.9° postoperatively ($p < 0.001$). Additionally, the mean tibiofemoral angle decreased from 182.1 ± 10.8° before surgery to 177.0 ± 3.5° after surgery ($p < 0.001$), reflecting correction of the varus or valgus deformity.

Pearson correlation analysis demonstrated a statistically significant positive correlation between preoperative flexion and postoperative flexion ($r = 0.372$, $p < 0.001$), and a negative correlation between tibiofemoral angle and postoperative flexion ($r = -0.291$, $p = 0.006$). No significant association was found between gender and postoperative flexion outcomes. To further investigate predictors of postoperative knee flexion, a linear regression model was developed, incorporating age, preoperative flexion, and tibiofemoral angle. The model accounted for 29% of the variance in postoperative flexion (adjusted $R^2 = 0.29$, $p < 0.001$). Both preoperative flexion ($\beta = 0.65$, $p < 0.001$) and tibiofemoral angle ($\beta = -0.22$, $p = 0.01$) were identified as statistically significant predictors. Notably, a 10° increase in preoperative flexion was associated with a 6.5° improvement in postoperative flexion, whereas a 10° reduction in tibiofemoral angle corresponded to a 2.2° increase in flexion postoperatively. Age did not significantly influence postoperative flexion ($\beta = -0.03$, $p = 0.45$).

Table 1: Patient demographics

Variable	Value
Total Patients	94
Mean Age	64.5 ± 6.8 years (range: 57–78)
Age Distribution	
- Over 65 years	72 patients (76.6%)
- Under 65 years	22 patients (23.4%)
Gender Distribution	

Variable	Value
- Male	40 patients (42.6%)
- Female	54 patients (57.4%)
Mean Weight	72.5 ± 8.2 kg (range: 60–92 kg)
Mean Height	**1.62 ± 0.07 meters (range: 1.54–1.75)**

Table 2: Preoperative and Postoperative Range of Motion and Clinical Outcomes

Parameter	Preoperative	Postoperative	p-value
Flexion °	102.3 ± 13.8	107.1 ± 10.5	<0.001
Extension °	5.9 ± 4.5	1.3 ± 2.9	<0.001
Tibiofemoral Angle°	**182.1 ± 10.8**	**177.0 ± 3.5**	**<0.001**

Table 3: Linear Regression Analysis for Predicting Postoperative Flexion

Variable	β-coefficient	Standard Error	t-statistic	p-value	95% Confidence Interval
Preoperative Flexion	0.65	0.130	5.00	< 0.001	0.39 – 0.91
Tibiofemoral Angle	-0.22	0.080	-2.75	0.01	-0.38 – -0.06
Age	**-0.03**	**0.040**	**-0.75**	**0.45**	**-0.11 – 0.05**

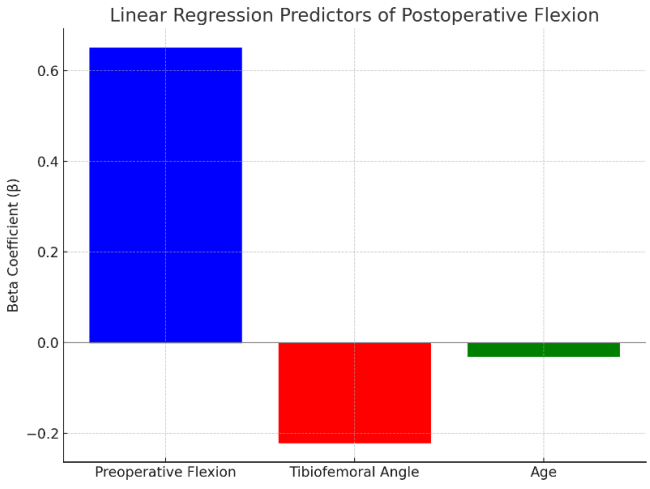

Figure 2 Linear Regression Predictors of Postoperative Flexion

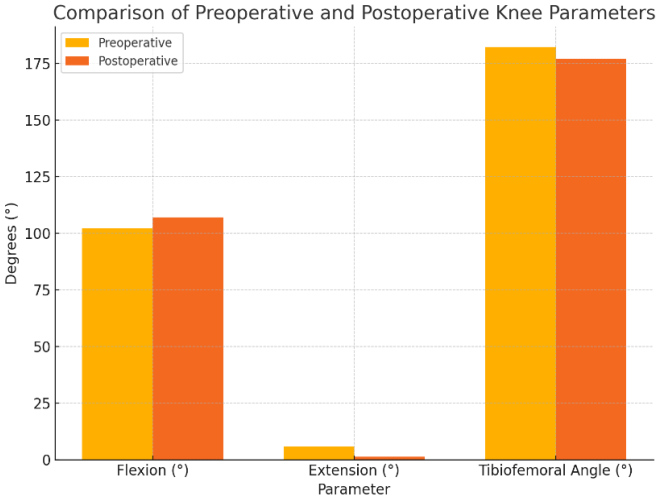

Figure 1 Comparison of Preoperative and postoperative Knee Parameters

DISCUSSION

The present study aimed to evaluate the influence of two key preoperative factors—knee flexion angle and tibiofemoral angle—on postoperative range of motion (ROM) in patients undergoing total knee arthroplasty (TKA) for knee osteoarthritis (OA). The findings contribute meaningfully to the growing body of literature focused on predicting functional recovery after TKA and have important implications for surgical timing, preoperative assessment, and postoperative rehabilitation planning (13). A significant improvement in postoperative knee flexion was observed, with the mean flexion increasing from 102.3° ± 13.8° preoperatively to 107.1° ± 10.5°

postoperatively. This improvement is not only statistically significant ($p < 0.001$) but also clinically relevant, as it directly impacts functional abilities such as ambulation, stair navigation, and overall joint performance (14). The strong predictive value of preoperative flexion on postoperative outcomes ($\beta = 0.65$, $p < 0.001$) supports earlier findings suggesting that patients with higher initial mobility are more likely to achieve superior postoperative ROM (15,16). Moreover, it reinforces the concept that preserving joint mobility prior to surgical intervention can lead to more favorable outcomes, emphasizing the benefit of not deferring surgery until severe joint stiffness or contracture sets in (17).

The tibiofemoral angle also demonstrated a statistically significant inverse correlation with postoperative flexion ($r = -0.291$, $p = 0.006$), indicating that greater preoperative varus deformity may be associated with improved postoperative ROM (18). This relationship likely reflects the biomechanical advantage of correcting malalignment during TKA, which restores joint congruency and facilitates smoother articulation. Similar observations in prior studies affirm the impact of coronal plane alignment on surgical outcomes and suggest that early surgical correction of deformities can optimize postoperative joint dynamics (19). Clinically, these findings underscore the importance of thorough preoperative evaluation. The integration of preoperative flexion angle and tibiofemoral angle into surgical planning could allow for more accurate prediction of patient-specific outcomes and refinement of rehabilitation protocols. Particularly for individuals with moderate OA and preserved motion, timely surgical intervention could offer enhanced postoperative mobility and greater long-term satisfaction (20).

One of the strengths of the study lies in its methodological consistency. All patients underwent TKA using the same surgical technique, implant design, and rehabilitation protocol, thereby minimizing confounding variables. The use of objective tools such as a universal goniometer and standardized radiographic analysis further added to the reliability of the measurements. In addition, the study addressed potential confounders by implementing strict exclusion criteria and applying robust statistical analyses including both correlation and regression models. However, several limitations merit consideration. The study was conducted at a single tertiary care center with a relatively modest sample size of 94 patients, potentially limiting the external validity of the findings. The patient cohort was predominantly elderly, with a mean age of 64.5 years, thereby reducing the generalizability of results to younger populations or those undergoing TKA for post-traumatic or inflammatory conditions. Furthermore, the follow-up period of three months, while adequate for early functional assessment, does not capture the long-term durability of postoperative gains in ROM or overall functional outcomes. Longer follow-up durations are essential to determine whether the early improvements in flexion are sustained over time and to assess their impact on quality of life and activity levels. In summary, the study highlights that preoperative knee flexion and tibiofemoral angle are significant predictors of early postoperative ROM following TKA. These findings support the clinical rationale for early surgical intervention in appropriately selected patients and reinforce the importance of individualized preoperative assessment. Future multicenter studies with larger, more diverse populations and extended follow-up periods are warranted to validate these findings and explore their applicability to long-term function and quality of life outcomes.

CONCLUSION

In conclusion, this study highlights the significant role of preoperative knee flexion angle and tibiofemoral alignment in predicting postoperative range of motion in patients undergoing total knee arthroplasty for osteoarthritis. The findings emphasize that individuals with better baseline flexion and varus alignment are more likely to experience favorable improvements in joint mobility after surgery. These insights support the importance of timely surgical intervention and individualized preoperative assessment to enhance functional outcomes and patient satisfaction. By integrating these factors into clinical decision-making, surgeons can better identify patients who may benefit most from early total knee replacement, ultimately contributing to more effective, patient-centered care.

Author Contribution

Author	Contribution
Hafiz Muhammad Noman*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Shaheen Iqbal	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published

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Sarmad Nasir Janjua	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Fanzer Khan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Saman Habib	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Nabeel Anwar	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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